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ASAPH HALL

PROFESSOR ASAPH HALL, one of the most noted of American astronomers, died on November 22 at the home of his son, Professor Angelo Hall, at Annapolis, Maryland, and was buried at Goshen, Connecticut, in the family cemetery on November 25.

Asaph Hall was born in Goshen, Conn., October 15, 1829. His ancestors were among the early English settlers of New England and their names appear in the records of the colonial wars and of the revolution. His grandfather, Asaph Hall, was a captain of the company organized at Cornwall, Conn., which assisted in the defense of Ticonderoga. His father, Asaph Hall, married Hannah Palmer, of Goshen, Conn., and Professor Asaph Hall, who has just died, was the eldest of six children by this marriage.

He received such early education as the youth of his time had access to at the country school and at Norfolk Academy and, after he had become or age, attended college at McGrawville, N. Y. There he met Angeline Stickney, a student and teacher of mathematics at that college, whom he subsequently married and who, throughout her life, gave herself devotedly to him and to his scientific work. Professor Hall's choice of astronomy was largely due to her suggestion and she was the first perhaps to recognize his unusual mathematical ability. After their marriage, they went to Ann Arbor, Mich., where Mr. Hall studied under Brünnow, the well-known

astronomer, at that time director of the Ann Arbor Observatory.

Professor Hall's career as an astronomer began at the Harvard Observatory, under William Bond, in 1857. His work there consisted mainly in the routine observatory work, but he quickly became an expert in the computation of the orbits of comets and began to show the admirable grasp of mathematical relations which later on made him an authority in problems of gravitational astronomy.

In 1862 he entered the Naval Observatory as assistant astronomer and in 1863 was appointed professor of mathematics in the United States Navy by President Lincoln, a position which he retained until retired, under the regulations, in 1891, on the completion of his sixty-second year.

The thirty years which Professor Hall spent at the Naval Observatory were full of fruitful work, both as an observer and in the higher sphere of mathematical investigation of astronomical phenomena. From 1862 to 1866 his work was that of assistant observer with the 9½-inch equatorial, then considered a very large instrument, and consisted in the main of observations of asteroids and comets. In 1867 he was in charge of the meridian circle; from 1868 to 1875 in charge of the 9½-inch equatorial; and from 1875 to 1891 in charge of the 26-inch equatorial, at the time of its erection the largest refracting telescope in the world. During these years he was the leader in many expeditions to distant parts of the world to conduct observations of special interest. In 1869 he went to Bering Strait to observe an eclipse of the sun; in 1870 to Sicily to observe an eclipse; in 1874 to Vladivostock to observe the transit of Venus, the voyage being made on the *Kearsarge*. In 1878 he had charge of an expedition to Colorado to observe the eclipse of the sun in that year; and in 1882 he went to Texas to observe the transit of Venus.

The contributions of Professor Hall to astronomy were so numerous that a mere enumeration of them would fill a long catalogue. Working astronomers have been familiar with his papers in the *Astronomische Nachrichten*, that universal journal of astronomical communication, for half a century.

His first discovery with the 26-inch equatorial, which was of great interest, was a white spot on the planet Saturn in 1876, by means of which a new and accurate determination of the rotation period of the planet was made.

In the summer of 1877, at the time of the near approach of the planet Mars, he made a systematic search for new satellites, which was rewarded by the most interesting discovery with which his name is connected, that of the two satellites Deimos and Phobos. Up to that time it had been believed that Mars had no moons and the discovery of two companions of this comparatively well-known planet, one of them revolving around the planet in a period less than one third of the revolution time of the planet itself, came to astronomers almost as an unwarranted innovation in the solar system. The investigation of the inner satellite has led to the most interesting results in the study of the evolution of planets and their satellites.

Next to these brilliant telescopic discoveries, the discovery of the motion of the line of the apsides of the orbit of Hyperion, one of Saturn's satellites, was perhaps Mr. Hall's most remarkable piece of work.

His long and systematic observations with the great equatorial at Washington were of special value, not only for the great accuracy with which they were made, but also for the admirable way in which they were joined to the work of other observers and made as nearly as possible comparable

with them. Perhaps no observer in any nation, unless it be Otto Struve, has contributed so long and valuable a series of observations with a single equatorial as is embraced in the work of Professor Hall.

This work lay mainly in three directions: first, planetary observations, consisting in the main of determinations of the positions of the satellites, with the consequent investigations of their orbits; second, observations of double stars with numerous investigations of the double star orbits; third, determinations of the stellar parallax. In each of these fields of astronomical activity Mr. Hall's work was of the highest value and led not only to interesting observational results, but to most elegant discussions of gravitational problems in the solar and stellar systems. His observations, in particular, of the system of the planet Saturn, including those of the rings, have been of primary importance in bettering our knowledge of that interesting planet.

In all this work Professor Hall showed not only a high order of skill as an observer, but he also developed a very high order of ability in his grasp of those mathematical relations involved in the treatment of the gravitational problems of our system of planets and satellites. His papers concerning the various problems arising out of the motions of planets and satellites brought him his highest recognition and showed him to be a man possessing an order of intellectual ability of exceptional character. It is not too much to say that he is one of a group of Americans of not more than a half dozen men at most who have attained high rank as mathematical astronomers.

The recognition of Professor Hall's work by various societies and governments is most significant of the character of the work itself. He received the gold medal of the Royal Astronomical Society of London, the Lalande prize of France, the Arago medal from the French Academy of Sciences, and was made a knight of the Legion of Honor. He was a member of the more important scientific societies in this country and abroad, being an honorary member of the Royal Society in England as well as of the French Academy and of the Royal Academies of Russia and Germany. As a member of the National Academy of Sciences of America he served for many years as secretary and later as its vice-president. He received honorary degrees from many colleges and universities, amongst others the degree of LL.D. from Yale and the same degree from Harvard at the celebration of its two hundred and fiftieth anniversary.

Retiring from the Naval Observatory at the age of sixty-two, in accordance with naval regulations, Professor Hall continued his work for some years at the observatory in order to complete those matters upon which he was particularly engaged. For some years after he was in charge of the observatory at Madison, Wisconsin, and in 1896 became a member of the faculty of Harvard University with the title of professor of mathematics, which he retained until 1901.

Professor Hall's first wife, Angeline Stickney Hall, died in July, 1892. Of this marriage four sons survive. In October, 1901, he married Mary B. Gothier, of Goshen, Conn., who survives him.

Professor Hall numbered amongst his friends the leading scientific men of Europe and of America. His correspondence, running back for more than fifty years, would form of itself an interesting account of the astronomy of his day. He was in temperament, in devotion, in the simplicity and singlemindedness of his life, a true man of science. For him no distractions of social recognition or money-making served to withdraw his attention from the science to which he had given his life. No

man in our generation and in our country has given a better example of that true simplicity and sincerity which are the distinguishing characteristics of the highest type of the scientific life. Those of us who worked with him as students, as assistants, as colleagues, revere his memory not less for the simplicity and sincerity of his personal life than for the work he wrought for astronomy. His career is an illustration of the possibilities open to an American boy, and his life has shed luster upon his country and upon his science.

Henry S. Pritchett

December 2, 1907

THE LIFE AND WORK OF JOSEPH LEIDY[1]

The statue just unveiled, of the late Joseph Leidy, reveals a most admirable portraiture of the greatest naturalist that this country, perhaps that any country, ever produced; for but few equalled, and none ever surpassed, Joseph Leidy in the exactness, variety and the comprehensiveness of his knowledge of natural history. Joseph Leidy, of French-German extraction, was born in this city, September 9, 1823, and died here, April 30, 1891. His whole life may be said to have been devoted to the study of natural history and was as simple, pure and noble as the objects of his lifelong study. Regarding with the spirit of a philosopher the petty incidents and annoyances that go to make up one's daily life, as only unavoidable interruptions to his life work, Leidy pursued the even tenor of his way. Happy in his domestic life, enjoying the society of his friends, generous and charitable, kindly and sympathetic to those with whom he came in daily contact, straightforward and honorable, incapable of deceit or of a mean or ungenerous thought or act, he lived his life beloved by all, and passed away without having made an enemy during his long career. Such having been the life of our distinguished fellow citizen, his eulogist, as might be expected, will have no incidents to relate such as the lives of great generals, statesmen, men of affairs afford. Nevertheless, when perhaps the latter are forgotten, the name and reputation of Joseph Leidy will be preserved in the many and valuable contributions he made to our knowledge of natural history. Well might he have said like Horace "Exegi monumentum aere perennius." Leidy's early education was obtained at private schools. He studied medicine at the University of Pennsylvania, graduating as doctor of medicine in 1844. He at once began the practise of his profession to which he devoted himself for about two years. For some time Dr. Leidy experienced that struggle with hardships and obstacles incidental to the lives of so many young physicians, but it was happily relieved by his election in 1853, at thirty years of age, as professor of anatomy in the University of Pennsylvania. This position he held with the most distinguished success till his death, a period of nearly forty years. While Dr. Leidy was universally recognized as the leading teacher of human anatomy in this country, his text-book being long a classic, he himself viewed anatomy not simply as a means to an end, of practical value to the practitioner of medicine and surgery, but as constituting only a part of the general subject of morphology; that is, of the general structure of plants and animals. As an illustration of the manner in which Leidy studied the human body may be mentioned his treatise on the "Comparative Anatomy of the Liver" which work can still be studied with advantage by the medical student. With the means of a livelihood assured through his professorship at the university,

[1] Address delivered at the unveiling of the Leidy statue, October 30, 1907, City Hall Plaza, Philadelphia.

and leisure to investigate, Dr. Leidy began that series of brilliant researches which made him, during a period of forty years, the most conspicuous ornament of the university and Academy of Natural Sciences, and that at a time when Cope, Meehan, Redfield, Cassin, LeConte, Horn, Tryon and Allen were among the active members at the regular Tuesday meetings of the academy—a galaxy of talent truly. Leidy's researches, communicated principally to the academy, and published in its *Journal* and *Proceedings,* embracing all branches of natural history and numbering over 550 contributions to our knowledge of nature, attracted the attention of this country, Europe and indeed of the whole world. Dr. Leidy's familiarity with all natural objects invariably impressed those brought in contact with him. If some minute infusorian was shown under the microscope, one would have supposed from his observation that he had devoted his life to the study of the Protozoa. A worm being submitted to him for identification his description of its structure would lead to the inference that his specialty was helminthology. One had only to see Dr. Leidy dissect a fly or a snail no bigger than a pin's head to realize that he was an admirable comparative anatomist. His drawings of the structure of insects and mollusks are made use of even at the present day by recent authorities to illustrate their text-books on entomology and conchology. While Dr. Leidy made no claim to being an authority on mineralogy, mineralogists consulted him in connection with their specialty, prominent jewelers in regard to the value of diamonds and other gems. As an illustration of the accuracy of his knowledge in this respect, it may be mentioned that on one occasion, when visiting the Centennial, Dr. Leidy recognized in one of the exhibits a mineral labeled beryl as being really topaz, and of great value. On careful examination by experts it was shown to be topaz and subsequently the specimen was sold for many thousand dollars. The speaker can testify as to his knowledge of botany, having accompanied him on a trip through the Rocky Mountains in company with one of the most critical of botanists, who was amazed at Dr. Leidy's familiarity with the western flora. He rarely if ever was at fault; if, however, he failed to identify a species correctly, with his characteristic honesty he was the first to acknowledge it. Of the innumerable streams and ponds in the neighborhood of Philadelphia visited in company with Dr. Leidy with the object of obtaining infusoria, etc., the speaker can not recall a single instance in which Dr. Leidy did not at once recognize the objects when viewed afterwards under the microscope. His work on the Rhizopoda is a monument to his skill as a microscopist. Some years ago the theory was advanced that catarrh and hay fever were produced by an infusorian animalcule, the *Asthmatos ciliaris.* Dr. Leidy having been requested to express an opinion in regard to the nature of the supposed infusorian at once recognized through his familiarity with this class of animals that the so-called infusorian animalculæ supposed to be the cause of disease were only "incomplete, deformed ciliated epithelial cells. It never crossed my mind that they were anything else than ciliated epithelial cells more or less modified by the condition of the catarrhal affection."[2] Leidy's discovery of the *Trichina* in the pig, explaining how man comes to be infested with that parasite and whereby thousands of lives have been saved, would alone have entitled him to recognition as one of the foremost helminthologists of the day—and which indeed he was considered. As is well known, Leidy was the pioneer in American paleontology.

[2] *American Journal of Medical Sciences,* 1879, p. 86.

Long before it was learned that the bad lands of Nebraska and other parts of the west constituted a veritable mausoleum of mammalian and other vertebrate remains, a fragment of a tooth was submitted to Leidy for examination, who without a moment's hesitation said it was part of a molar of an extinct kind of rhinoceros. The correctness of this determination was questioned when the tooth was brought to the academy, it being almost incredible that a rhinoceros could ever have lived in Nebraska, and further, the academy did not possess at that time the skeleton of a rhinoceros with which to compare the tooth in question. The correctness of Dr. Leidy's opinion was, however, fully sustained soon afterwards by the discovery of several entire molars with a complete skull of the animal. Dr. Leidy told the speaker that the remaining part of the tooth of which he had examined the fragment was found in situ in the skull, and that the broken fragment adapted itself perfectly to it. With the revealing of the extinct life of the west Dr. Leidy, whose almost inexhaustive knowledge of the vertebrate skeleton qualified him, and at that time him alone, to interpret fossil remains, began at the academy that series of epoch-making researches which, in his hands and those of his successors, established on paleontological evidence the doctrine of evolution so that no one competent to appreciate that evidence has since ever doubted its truth. Indeed, considering the circumstances, the few skeletons to be found in museums in this country at that time with which the remains of extinct animals could be compared, Leidy's determination of the tooth just referred to as being that of an extinct rhinoceros was as remarkable and as replete with results as Cuvier's identification of the bones found in the quarries of Mont Martre as being those of an extinct opossum. Indeed as far back as 1853—five years before the appearance of Darwin's "Origin of Species"—Dr. Leidy observed:

The study of the earth's crust teaches us that very many species of plants and animals became extinct at successive periods, while other races originated to occupy their places. This probably was the result in many cases of a change in exterior conditions incompatible with the life of certain species and favorable to the primitive production of others. Living beings did not exist upon earth prior to their indispensable conditions of action, but wherever these have been brought into operation concomitantly the former originated. Of the life present everywhere with its indispensable conditions and coeval in its origin with them what was the immediate cause? It could not have existed upon earth prior to its essential conditions and is it therefore the result of these? There appear to be but trifling steps from the oscillating particle of organic matter to a Bacterium; from this to a Vibrio; thence to a Monas, and so gradually up to the highest orders of life. The most ancient rocks containing remains of living beings indicate the contemporaneous existence of the more complete as well as the simplest of organic forms; but nevertheless life may have been ushered upon earth through oceans of the lowest types long previously to the deposit of the oldest paleozoic rocks as known to us.

Where, may it be asked, can there be found in the whole range of biological literature a more concise statement in regard to the origin of life, the extinction of species, the survival of the fittest—in a word, of Darwinism?[3] Again, in regard to the descent of man, Leidy suggested:[4]

That but little change would be necessary to evolve from the jaw and teeth of *Notharctus* that of a modern monkey. That same condition that would lead to the suppression of a first premolar in continuance would reduce the fangs of the other premolars to a single one. This change with a concomitant shortening and increase of depth of the jaw would give the character of a living Cebus. A further reduction of a single premolar would give rise to the condition of the jaw in the old world apes and man.

As a fitting recognition of Dr. Leidy's

[3] Smithsonian Contributions, 1853.

[4] "Extinct Vertebrate Fauna," 1873, p. 90.

services to the Academy of Natural Sciences he was unanimously elected its president in 1881, he having served the institution as chairman of the board of curators continuously for forty years. Both positions he held at the time of his death. That the value of Dr. Leidy's contributions to science have not been over-estimated by his personal friends and admirers is shown by the honors conferred on him by the learned institutions both at home and abroad, and by the marked courtesy and attention paid to him by the most distinguished savants on the occasion of his visits abroad. Among the honors conferred upon Dr. Leidy may be mentioned the LL.D. of Harvard, the medals of the Royal Microscopical and Geological Societies of London, the Cuvier medal of the Academy of Sciences of Paris, membership in all the most important learned societies in this country and in those of England, France, Germany, Russia, Italy, Norway, Sweden, Hungary, Denmark, Spain, Portugal and Brazil. Surely it was a fitting tribute to one so honored at home and abroad as Joseph Leidy that his personality should be embodied in enduring stone in his native city, even though his works were an imperishable monument to his memory.

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THE ARC AND THE SPARK IN RADIO-TELEGRAPHY[1]

THE discovery by Heinrich Hertz between 1887 and 1889 of experimental means for the production of electric waves and Branley's discovery that the conductivity of metallic particles is affected by electric waves form the foundation on which, in 1896, Signor Marconi built up his system of wireless telegraphy.

[1] Evening discourse before the British Association for the Advancement of Science, Leicester, 1907.

Many of the early investigators certainly had glimpses of a future system of being able to transmit messages without connecting wires, for as early as 1892 Sir William Crookes predicted in the *Fortnightly Review* the possibility of telegraphy without wires, posts, cables, or any of our costly appliances, and said, granting a few reasonable postulates, the whole thing comes well within the realms of possible fulfilment.

Two years later Sir Oliver Lodge gave his memorable lecture on the work of Hertz, and carried the matter a step nearer the practical stage.

There will not be time to dwell to-night on the early history of the art and its development. It will be necessary, however, to explain some of the fundamental properties of signaling by means of Hertzian waves in order to be able to bring out clearly the relative advantages and disadvantages of the two rival methods now in practical use for producing Hertzian waves for wireless telegraphy.

The fundamental part of the transmitting apparatus may be said to consist of a long conductor, generally placed vertically, in which an alternating or oscillating current is set up by some suitable means. Such a conductor radiates energy in the form of Hertzian waves at right angles to itself into space, in very much the same way that an ordinary candle sends out light in all directions. This radiation, though it is strictly in the nature of light, is invisible to our eyes, as the frequency is too low.

If we set up any other conductor approximately parallel to the first, there will be produced in this second conductor alternating or oscillating currents having the same frequency as those in the first conductor, and which can be detected by suitable instruments.

The simplest and one of the earliest

methods for producing Hertzian waves for use in wireless telegraphy consisted in charging up by means of an induction coil a vertical insulated conductor, which was allowed to discharge itself to earth by means of a spark taking place between its lower end and another conductor which was connected to earth. To detect the Hertzian waves, Marconi employed an improved form of the Branley filings tubes, which is known as the "coherer."

In order to transmit messages the radiation is started and stopped so as to form short and long signals, or dots and dashes of the Morse code, out of which the whole alphabet is built up in the well-known way.

As I have already stated, the radiation takes place round the vertical conductor approximately equally in all directions. Suppose that I set up my transmitting apparatus here in Leicester, a receiving station set up either in Nottingham, Derby, Rugby or Peterborough would be able to receive the message equally well. Should I wish to send a message from here to Nottingham at the same time that Derby wishes to speak to Rugby, then the receiving station at Nottingham would receive both the message from Leicester which it should receive and the message from Derby which it was not required to receive.

To get over this difficulty, known as "interference," a large number of devices have been patented. The most successful in practise is syntony, or tuning: in this method each station has allotted to it one definite frequency or tune, and the apparatus is so arranged at each station that it will only be affected by messages which are radiated by other stations on its own frequency or tune, and not by any other radiations. To take a musical analogy, supposing I had somebody who was either deaf to all notes of the piano except, say, the middle C, or had such a musical ability that he could tell at once when I struck the middle C; then I could transmit to that person a message in the ordinary Morse code by playing on the middle C, and that person, whom I shall call Mr. C, would not take any notice of the fact that I might also be playing on the notes D, E, F, G, etc., but Mr. C would confine his attention entirely to what is being done with the middle C. It is conceivable that I might find a series of persons or train them so that they could each pick out and hear one note only of the piano, irrespective of what was being played on the other notes or of any other noises that were taking place. Taking an ordinary seven-octave piano and neglecting for a moment the black notes, this would give me fifty-six distinct notes on which I could transmit messages; so that, transmitting from Leicester, I might send messages simultaneously to fifty-six different towns.

The number of possible simultaneous messages depends on the number of octaves there are on the piano used, and on how close together the different notes are which can be used without producing confusion. For instance, it might be quite easy to train someone to distinguish with certainty between C and E, and pick out signals on C at the same time that signals are being sent on E. It is certainly more difficult to do this with two notes that are closer together, say C and D, and still more difficult if the half-tones are used as well. The problem, therefore, in wireless telegraphy is to arrange the receiving apparatus so that it can hear, or perhaps I should say, more accurately, so that it can only see, notes of one definite frequency or pitch, and not be affected by any other notes, even though of but slightly different pitch. Another requirement to obtain good working is that we should use as little power as possible at our transmitting station consistent with obtaining enough power in our receiving instruments to work them with certainty.

I have a mechanical model to illustrate how we are able to make our receiving instruments very sensitive to one frequency and only slightly affected by frequencies which differ but slightly from its proper frequency.

The transmitter in the model consists of a disc that can be rotated slowly at any speed I like, with a pin fixed eccentrically on its face. This pin can be connected to a vertical wire which moves up and down as the disc rotates. I shall assume that the movement of this wire corresponds with the movement of the electricity in the vertical conductor. As a receiving apparatus I have a pendulum, and representing the ether between the transmitter and receiver I have an elastic thread connecting the pin in the disc to the pendulum.

When I set the disc rotating slowly the elastic thread is alternately stretched out and relaxed and the pendulum is a little affected. If I gradually increase the speed of the disc at one definite speed it will be found that the pendulum is set into violent oscillation, and by observation it will be found that when this is the case the disc makes one complete revolution in exactly the same time that the pendulum would make one complete swing if left to itself; that is to say, that the disc and the pendulum make the same number of swings per second or have the same frequency; in music they would be said to be in tune with each other. If instead of allowing the disc to rotate continuously I allow it to make only half a dozen revolutions, then the pendulum will be affected, but much less strongly. The greater the number of revolutions the disc makes up to a certain maximum number the more the pendulum will be caused to swing.

Instead of starting and stopping the disc I can keep the disc rotating and start and stop the pulls on the elastic thread by moving the pin in the face of the disc in and out from the center, which produces a movement which much more nearly corresponds with the actual current in the vertical wire as used in spark telegraphy.

It is necessary here to explain the relationship that exists between the wave-length, the frequency and the velocity of propagation of Hertzian waves. The waves travel with, as far as we know, the same velocity as light, namely, 300,000,000 meters, or 186,000 miles, per second. Between these quantities we have the relationship that the product of the wave-length by the frequency is equal to the velocity of propagation, or, as I have already mentioned, the velocity of light.

The wave-lengths which are of practical use in wireless telegraphy at the present time range between 100 and 3,000 meters, though, of course, it is quite possible to use for special purposes wave-lengths outside these limits. The corresponding frequencies in practical use are therefore between 3,000,000 and 100,000 complete periods per second. We require, therefore, to produce in the vertical conductor alternating or oscillating currents of any frequency within this range, and to have a sufficient number of oscillations following one another without interruption to allow of good syntony being obtained.

There are three methods of producing these currents—namely, the alternator, the spark and the arc methods.

There are great difficulties in the way of constructing an alternator to give such high-frequency currents, and I can best illustrate this by taking an example. Suppose that it is required to build an alternator to work at the lowest frequency, namely, 100,000 periods per second, and let us assume that we can drive this alternator by means of a turbine at the high speed of 30,000 revolutions per minute. This alternator could not have a diameter much above six inches for fear of bursting; and,

as it makes 500 revolutions per second, it would have to generate 200 complete periods for each revolution, so that the space available for the windings and poles for one complete period will be less than one tenth inch, a space into which it is quite impossible to crush the necessary iron and copper to obtain any considerable amount of power. In spite of the small space that we have allotted to each period, as there are 100,000 periods per second, the speed of the surface of the moving part works out at over 500 miles per hour. A small alternator has been built to give over 100,000 frequency, but the amount of power it produced was extremely small. Several experimenters have stated lately that they have built alternators giving these high frequencies and a considerable amount of power, but, so far as I am aware, there is no reliable data available as to the design of these machines.

If it should prove possible to construct alternators for these very high frequencies, we shall be able to obtain a sufficient number of consecutive oscillations of the current in the aerial of definite frequency to enable very sharp syntony to be obtained. Not only will this greatly reduce interference troubles in wireless telegraphy, but such alternators will be of the greatest value for wireless telephony.

The earliest method of producing high-frequency oscillations was proposed by Lord Kelvin, who pointed out that if a Leyden jar or condenser be allowed to discharge through a circuit possessing self-induction or electrical inertia, then under certain conditions the discharge of the jar is oscillatory, that is to say, that the electricity flows backwards and forwards in the circuit several times before the jar or condenser becomes finally discharged. I think that perhaps the best way to make this matter clear is by demonstrating experimentally with an oscillograph the nature of the discharge of a condenser, and how it is affected by the resistance and self-induction in the circuit. As a mechanical analogy one may look upon the charged condenser as a weight attached to a spring which has been pulled away from its position or rest. To discharge the condenser we let go the weight and it begins to oscillate backwards and forwards, and, after making a greater or less number of oscillations, finally comes to rest. The number of oscillations per second will depend upon the strength of the spring and the mass of the weight, which correspond with the capacity and self-induction in our electrical circuit. The number of oscillations before the weight finally comes to rest is determined by the friction which tends to stop the weight, or by the resistances and other losses in the electrical circuit.

In practise the aerial conductor acts as a Leyden jar or condenser. It is charged with electricity and allowed to discharge, the current oscillating backwards and forwards in the aerial during the discharge. In many installations Leyden jars or condensers are electrically connected to the aerial, so that the oscillations taking place in them are transmitted to the aerial. Any remarks, therefore, that I may make as to the oscillations which may be set up in condensers apply equally well to the oscillations in the aerial in wireless telegraphy.

For wireless telegraphy it is usual to charge the condenser or aerial by means of an induction coil or an alternator to a very high voltage, and it is allowed to discharge by means of a spark between the two electrodes which form the ends, so to speak, of a gap in the electrical circuit. As long as the pressure is low the spark gap is a perfect insulator; when the pressure becomes high enough the air between the electrodes breaks down and a spark passes the gap, becomes conducting, and allows the condenser to discharge. The property of

the spark-gap of passing almost instantaneously from a condition of being an insulator for electricity to being an extremely good conductor for electricity is of the utmost value in the spark method of wireless telegraphy. The more perfectly the spark-gap insulates before the discharge takes place, and the more perfectly it conducts after the discharge has taken place, the better it is for our purpose.

If I take two electrodes sufficiently far apart in air and gradually raise the electrical pressure between them, the first indication that anything is going to happen is the formation of fine violet aigrette on the more pointed or rougher parts of the electrodes. This is known as the brush discharge. By gradually raising the pressure, this brush discharge extends further out into the air, until finally the air between the two electrodes becomes so strained that it breaks down and the real spark passes.

The long thin spark that occurs in this case is not very suitable for wireless telegraphy, as its resistance is too high. Ordinary lightning flashes are good examples of long sparks on a very large scale. If instead of working with the electrodes far apart they are placed nearer together, and if the electrical pressure is supplied from a very powerful source, then directly the spark passes it forms a thick discharge having the appearance of a flame in which the nitrogen of the air is actually being burnt; a process which, it is hoped, in the future may have immense importance in the supply of artificial nitrates for agriculture. This flame-like discharge has a low electrical resistance, but has the effect that it so heats or modifies the air that it is difficult to get the air to insulate again, after one discharge, ready for the next.

If a large quantity of electricity is discharged through the spark-gap, and if the spark lasts a very short time compared with the interval between successive sparks, then a highly conducting spark can be obtained, as well as a good insulation between the sparking terminals when no discharge is passing.

In order to help to bring the gap back to its insulating condition after each discharge, many devices are employed, such as subdividing the spark into several shorter sparks, cooling the electrodes, blowing air across the spark-gap, etc. When the condenser, or antenna, discharges through the spark-gap, oscillations are set up which radiate Hertzian waves.

In practise in wireless telegraphy it is difficult to obtain a large number of oscillations during each discharge as corresponding with each oscillation; the antenna radiates energy. A large number of oscillations means, if we keep amplitude of each the same, that we are radiating a large quantity of energy. Besides this radiated energy, which is useful for transmitting messages, there is also energy wasted in heat in the spark-gap, in the conductors, in the glass or other insulation of the condensers. It is this useless part which we require to make as small as possible.

I have lately had an opportunity to determine how many oscillations actually take place in a certain wireless transmission. The experiment was made by photographing the spark as seen in a mirror rotated at a very high speed, and it was found that each spark consisted of nine or ten complete oscillations.

If all the oscillations had been of equal strength or amplitude, and if the receiving circuit had been similar to my pendulum in my mechanical model, then there would be very little to be gained by increasing the number of oscillations. As the oscillations die away in the spark method, two or three times this number would probably be required for the best effect. As a matter of experiment very good tuning was obtained

with the wireless transmission referred to above.

As an example of the sharpness of tuning obtainable by the spark method the following test carried out on the Lodge-Muirhead installation at Hythe may be of interest.

The station at Hythe had to receive messages from Elmers End at a distance of fifty-eight miles over land, in spite of the fact that the Admiralty station at Dover, only nine and one fourth miles distance, was transmitting as powerfully as it could, in order to produce interference, and that the regular communications were going on in the channel between the shipping. It was found possible with a difference of wave-length of 6 per cent. to cut out the interference from the Dover station.

In the arc method of producing continuous oscillations we employ, as before, a condenser and self-induction; but, instead of charging the condenser to a high voltage and allowing it to discharge by means of oscillations which die away, and then repeating the process over and over again, we actually maintain the condenser charging and discharging continuously without any intermission, so that we practically obtain a high-frequency alternating current in the aerial.

To impress the difference on your minds, I have an incandescent lamp, which I switch on and off rapidly about ten times, and then after a short time I repeat the same flickering of the light, and so on. The flickering of the light corresponds with the oscillations in the ordinary spark method, and the time spaces between the flickers represent the times during which the condenser or antenna is being charged ready to produce a fresh series of oscillations. In practise we may have as many as, say, a couple of hundred discharges of the condenser a second, and during each discharge we may get, say, ten complete oscillations, each oscillation lasting one millionth of a second, if the wave-length is 300 meters; thus the total time that the condenser is discharging is only one one-hundred-thousandth of a second, or one five-hundredth part of the interval of time between two successive discharges. My lamp here flickers about five times per second, and makes ten flickers before it goes out; the total time that it is flickering is two seconds, and the time before it should start to flicker again to correspond with the practical wireless case is therefore 1,000 seconds, or rather over a quarter of an hour. If now I represent continuous oscillations, such as are obtained by the arc method with this lamp, I shall simply keep the lamp flickering continuously, and there will be no intervals whatever.

The arc method of producing continuous oscillations is founded on my musical arc. In order to explain this I must demonstrate some of the properties of the direct-current arc. If I vary the current flowing through the arc very slowly and note the potential difference corresponding with each value of the current, keeping everything else constant, I obtain a curve generally spoken of as the characteristic of the arc. These curves under different conditions have been very thoroughly investigated by Mrs. Ayrton.

With the carbon arc between electrodes in air the voltage decreases very rapidly when the current is gradually increased, starting from very low values. As the current becomes larger the rate of decrease of the voltage becomes less and less until it is, comparatively speaking, quite small, with a current of ten or twelve amperes. With the arc between metal electrodes similar results are obtained, except that the discontinuity in the curves, called the hissing point by Mrs. Ayrton, takes place at very small currents, generally well below an ampere.

With arcs burning in hydrogen, Mr. Upson has found that the curves are generally much steeper for the larger values of the current than for the corresponding arcs burning in air. This point is of great importance as explaining the value of the hydrogenic atmosphere used by Poulsen and referred to later.

In general, I may therefore say for the above arcs that increase in current through the arc is accompanied by decrease of the potential difference between its electrodes, and *vice versa* decrease of the current causes increase in the potential difference; on the other hand certain arcs, such as the arc between cored carbons, behave in an opposite manner, that is to say, current and potential difference increase and decrease together.

I demonstrated in 1900 that if I connect between the electrodes of a direct current arc (or other conductor of electricity for which an increase in current is accompanied by a decrease in potential difference between the terminals) a condenser and a self-induction connected in series, I obtain in this shunt circuit an alternating current. I called this phenomenon the musical arc. The frequency of the alternating current obtained in this shunt circuit depends on the value of the self-induction and the capacity of the condenser, and may practically be calculated by Kelvin's well-known formula.

Besides the condition that an increase of current must be accompanied by a decrease in potential difference, it is necessary that the relative decrease in potential difference produced by a given increase in current, that is to say, the steepness of the characteristic, shall exceed a certain minimum value which depends on the losses in the shunt circuit. It is also necessary that an increase in current shall be accompanied by a decrease in potential difference, even when the current is varied very rapidly.

Let us consider what takes place when I connect this shunt circuit to an arc. At the moment of connection a current flows from the arc circuit into the condenser circuit, which tends to reduce the current flowing through the arc. This reduction of the current through the arc tends to raise the potential difference between its terminals, and causes still more current to flow into the condenser circuit, and I now have a condenser charged above the normal voltage of the arc. The condenser, therefore, begins to discharge through the arc, which increases the arc current and decreases the potential difference, so that the condenser discharges too much; the reverse process then sets in; the condenser becomes successively overcharged and undercharged, due to the fact that, instead of the potential difference between the terminals of the arc remaining constant and allowing the condenser to settle down with its proper corresponding charge, the potential difference actually decreases when the condenser is discharged and increases when it is charging, so as to help to keep up the flowing backwards and forwards of the current indefinitely.

The oscillograph wave forms show what is going on very clearly, and they show that in general the swing of the current in the condenser circuit attains such a magnitude that when the condenser is charging it takes the whole of the current away from the arc, so as to make the arc, although burning on a direct current, a pulsatory arc. The pulsation of the current through the arc causes the vapor column to grow bigger and smaller, and the light to vary. When the vapor column grows bigger and smaller it displaces the air around it and produces a note the pitch of which is determined by the frequency of the current in the shunt circuit.

The values of the capacities of a series of condensers have been calculated by

Kelvin's formula to give the frequencies corresponding with a musical octave, and the nearest values in an ordinary laboratory box of condensers have been taken and connected to a keyboard. The result shows how nearly Kelvin's law is obeyed.

With this apparatus I can demonstrate the importance of tuning in electrical circuits and perform electrically some experiments which I have already performed mechanically earlier this evening. I use the large coil which forms the self-induction in the circuit shunting the arc as a transmitting circuit for wireless telegraphy by the magnetic induction or Preece method, and I have a receiving circuit consisting of a coil of wire connected to a small lamp and not connected in any way to the transmitting circuit. At a certain short distance between the transmitting coil and the receiving coils the indicating lamp lights if I cause my arc to sound *any* one of the notes of the octave, and so produce an alternating current of corresponding frequency in the transmitting coil. If I now tune the receiving circuit, by connecting a condenser in it, the lamp on the receiving circuit will light at about five times the distance; but it will only light when one definite note is sounded by the arc. These are the two distinct advantages of tuning, namely, greater distance and syntony, or responding to only one definite note.

For wireless telegraphy by means of Hertzian waves, based on my arc method, we require much higher frequencies in the shunt circuit. If we attempt to obtain this higher frequency from the ordinary arc burning between solid carbons in air, we find that above a certain limit the oscillations will no longer take place. This is due to the fact that we are varying the current through the arc at this higher frequency too quickly for an increase in current to be accompanied by a decrease in potential difference. I have demonstrated that if I only vary the current through the ordinary current arc sufficiently rapidly, then an increase in current is accompanied by a proportionate increase in the potential difference, and the arc behaves just like an ordinary resistance. If we work with very small current arcs we can obtain high-frequency musical arcs burning in air either between carbon or metal electrodes.

In a paper read before the International Electrical Congress at St. Louis in 1904 Mr. Poulsen showed that by placing the arc in a flame it was possible to obtain higher frequencies than when the arc was burning in air. Following this up Mr. Poulsen came to the conclusion that the best results were obtained when the arc was burning in hydrogen, or a gas containing hydrogen; and he further added a magnetic field around the arc somewhat similar to that which has been previously used by Elihu Thomson.

The arc burning in coal gas in a powerful transverse magnetic field was used by Poulsen in his early experiments to produce the high-frequency current necessary for wireless telegraphy between Lyngby and Esbjerg in Denmark. This apparatus has been further improved, and is now employed by the Amalgamated Radio-Telegraph Company in their station at Cullercoates and the other stations that they are erecting.

In both the arc and the spark methods of wireless telegraphy we employ a high-frequency alternating current in the aerial conductor. The essential difference between the two methods lies in the fact that with the spark method our alternating current in the aerial conductor first increases to a maximum value and then dies away rapidly, making only a limited number of oscillations, whereas in the arc method the

oscillations are maintained continuously of unvarying amplitude.

With the arc method we are further able to choose the number of consecutive oscillations which make up each signal sufficiently great to obtain the very best syntony. On the other hand, improvement in the arrangement and construction of the apparatus for the spark method has so increased the number of oscillations corresponding with each spark that it may be that we shall be able to obtain a sufficient number in each train to give as good syntony by this method as that obtained with the arc method.

The arc method seems eminently suitable for very high speeds of working. As the oscillations are quite continuous, we can cut them up into groups to form the dots and dashes of the Morse alphabet, just as if we were working with a continuous current such as is used on land lines, so that there seems no reason why as high a speed of working should not be obtained from the arc method of wireless telegraphy as is obtainable by automatic signalling on land lines; for it is to be noted that the dot or shortest signal of the Morse alphabet, even at a speed of three or four hundred words per minute, will last long enough to consist of many hundreds of oscillations of the current in the aerial, so that there will be plenty of oscillations in the group forming the dot to give good syntony.

Turning to the spark method for high working speeds, we find a difficulty in that the dot of the Morse alphabet must at least occupy the average time required to charge the condenser or aerial and produce one spark, and preferably sufficiently long for several. We are therefore obliged in the spark method to use a high rate of sparking for high-speed signaling. This difficulty has not become very serious with the present low speeds of sending. When we come to use considerable amounts of power to transmit messages over long distances, and we also require a high speed of working, the practical difficulty in constructing apparatus suitable for sufficiently rapid sparking will become serious.

Mr. Marconi in 1905 claimed to have already reached a speed of 100 words per minute by the spark method, and lately there has appeared in the technical press examples of high-speed signaling by the British Post-office over a distance of fifteen miles in which readable signals were received at a speed of seventy words per minute.

Turning to the receiving end, almost all the receivers that have been used in the spark method can be equally well used for the arc method; for it must be remembered that the transmission in either case is affected by Hertzian waves traversing space, and that the only fundamental difference consists in the number of oscillations in each train of waves. It must be noted, however, that in those methods in which a telephone receiver is used it is necessary to break up the continuous oscillations of the arc method into groups succeeding one another sufficiently rapidly to produce an audible sound in the receiver; for in the spark method the sounds we hear in the receiver correspond with the succession of impulses of the diagram, one for each spark at the transmitter. This chopping up of the continuous wave-train so as to produce audible signals in the receiving apparatus can be done either at the transmitting end or in the receiving apparatus. An example of this latter method is Poulsen's ticker.

The question whether receiving apparatus can be arranged so as to receive messages from stations equipped with the spark apparatus and from stations equipped with the arc apparatus is a matter of enormous importance at the present moment in view of the probable ratification of

the Berlin Convention, which imposes an obligation on all commercial stations to intercommunicate without regard to the make or system of transmitting apparatus employed. I am of the opinion that there will be no difficulty in carrying this into effect provided that the stations using the spark method send out long trains of waves, as they should do to obtain syntonic working, which is also called for by the Berlin Convention.

An extremely interesting development which is now progressing rapidly owing to the possibility of producing continuous oscillations by the arc method is wireless telephony. Suppose that we can vary the intensity of the oscillations in a manner corresponding with the vibrations of the air which constitutes sound and speech, then we should obtain at the receiving stations a train of Hertzian waves whose amplitude varies in a corresponding way; by allowing these waves to act on a telephonic receiver which is sensitive to the intensity of the waves we shall obtain in the telephone a reproduction of the sounds. This has actually been carried into effect by employing an ordinary microphone to modify the current through the transmitting arc so as to vary the intensity of the oscillation current produced, and by employing what is known as a point-detector and a telephone at the receiving station.

Another method which may be used consists in causing the microphone to vary the frequency of the oscillations of the generator, and by arranging the receiver so that it is more or less strongly affected according to the frequency of the received waves.

I am informed that such good results have already been obtained on the experimental stations for wireless telephony that it is proposed to equip stations at Oxford and Cambridge for the further perfecting of this application.

It is greatly to be desired that wireless telephony may develop rapidly, as it seems to me that for the purpose of communicating with ships wireless telephony will have great advantages over wireless telegraphy.

I am deeply indebted to Mr. Colson for all the facilities that he has placed at my disposal, and to his engineers for their assistance, which has enabled me to carry out the experiments in the lecture; and I have also to thank the tramway department for the special supply of current.

W. DUDDELL

SCIENTIFIC BOOKS

Experimental Zoology. By THOMAS HUNT MORGAN. New York, The Macmillan Co. 1907. Pp. xii + 454.

The field of experimental zoology has of late years been greatly extended and includes problems of widely different nature. The title of this book justifies the expectation of finding between the covers an attempt to bring together the results of experiment in the various fields and at the same time raises in the mind of the reader the question as to how the author has found it possible to treat adequately in some four hundred and fifty pages the data and problems involved. This question is answered in part, however, by the preface and table of contents, from which it appears that experimental embryology, regulation and animal behavior are not included within the scope of the book because, as the author states, they have recently received full consideration and, furthermore, would require too much space to be included in a single volume.

In short, the book treats primarily of those subjects and problems of experimental zoology which have not been considered in other books. This limitation necessarily defines its scope in a somewhat arbitrary manner and without relation to the problems involved. It is a fair question, therefore, whether the subject-matter of the book justifies its title: it would seem that some less inclusive title would have been more fitting.

In the preface the author states that

The central problem of morphology—the causes of changes in form or at least the determination of the conditions under which changes of form occur—will furnish the main theme of this treatise.

On reading this, one is forced to ask how any adequate consideration of this problem is possible without reference to experimental embryology and form-regulation. As a matter of fact the book treats almost solely of those fields in which the results of experimentation can not as yet be analyzed nor definite conclusions reached concerning the relation between conditions and the complex effect. Consequently the consideration of the morphological problem is of necessity very general and in certain respects rather barren of results.

The subject-matter of the book is treated under six heads or sections, viz.: Experimental Study of Evolution, Experimental Study of Growth, Experimental Studies in Grafting, Experimental Studies of the Influence of the Environment on the Life Cycle, Experimental Study of the Determination of Sex, Experimental Study of Secondary Sexual Characters.

The first of these sections, "Experimental Study of Evolution," comprises about half the book and includes chapters I.–XIV. Briefly stated the principal subjects considered are: the influence of external conditions on animal structure and the inheritance of changes thus produced, the inheritance of acquired characters, hybridization and the behavior of the germ-cells in hybridization, inbreeding and selection.

Only a few points can be taken up here. As regards the inheritance of acquired or somatic characters Professor Morgan points out that experimental data have not, up to the present, supported the hypothesis and maintains that until some positive evidence is presented we can not accept it as a well-established theory.

In the chapters on hybridization special stress is laid on the importance of Mendel's law and much space is devoted to an account of the experiments which bear upon it. In conclusion the author holds:

That Mendel's law accounts in many cases for the results and is therefore an invaluable acquisition to our method of interpretation; yet in some other cases it is evident that the inheritance is not strictly Mendelian. Used with discretion the law may still unlock many problems (p. 166).

At various points, however, notably on pp. 77 et seq. and again on p. 169, Morgan questions the so-called purity of the germ cells and points out that in various cases it is possible to bring out certain characters which should not be present if the germ cells are pure in the Mendelian sense. He suggests the hypothesis of an alternating dominance and recessiveness in the germ cells instead of purity as a means of accounting for the results.

As a matter of fact neither this suggestion nor Mendel's law contains any solution of the problems involved. Both are merely attempts to state in general terms what takes place in certain cases of hybridization and as such constitute only a formulation of the problems. Moreover, the chapters on hybridization show very clearly that work along this line has not yet attained the point where the problems involved can be clearly and consistently stated. Even Mendel's law, which is commonly regarded as the most important generalization attained thus far in this field, applies at best only to certain cases and Morgan disputes the correctness of one of its fundamental assumptions, viz., purity of the germ cells.

In a discussion of the phenomena of maturation of the germ cells in relation to Mendel's law attention is called to the arbitrary character of the assumptions required as regards the distribution of characters, and the fact that the chromosomes have not been demonstrated to be the sole bearers of hereditary qualities is emphasized. Incidentally it may be noted that maturation is considered as involving in all cases a transverse and a longitudinal division of the chromosomes, no mention being made of those cases in which two longitudinal divisions are believed to occur, although they constitute an argument in support of the author's position.

While the Mendelian terminology is freely used, we find no attempt to discuss or analyze the terms employed. Much has been written

of late regarding dominance, recessiveness, latency, etc., and it is highly desirable to keep in mind the fact that all these abstractions are really expressions of our ignorance.

Although the terms "character" and "unit-character" are frequently employed no definitions are given nor do we find any discussion of the possible nature of characters except in the section on sex determination, where morphological and physiological conceptions are briefly contrasted (pp. 420–422), the author favoring the physiological.

As in earlier writings, Morgan follows de Vries in drawing a sharp distinction between mutations and fluctuating variations and inclines toward the view that species arise by mutation and that selection does not originate but merely eliminates.

The second section, "Experimental Study of Growth," is rather brief, comprising an introductory chapter, in which normal growth, senescence, length of life, and absorption of parts are briefly discussed; a second chapter, on "External Factors that Influence Growth," and a third, on "Growth and Regeneration." Any treatment of the subject of growth on an experimental basis from which the data of experimental embryology and form-regulation are excluded must of necessity be incomplete and in certain respects unsatisfactory, and this section does not escape these disadvantages of limitation.

In the introductory chapter growth is defined as "an increase in the volume of the living material" (p. 240). According to this definition the increase in volume of bone, shell and other skeletal structures is not growth. Morgan himself is not consistent in his use of the term; within half a page of the definition he speaks of "steady and rapid growth due to imbibition of water" (p. 241) and on page 258, in discussing the effects of salts on growth, the experiments of Herbst and Maas on the relation between certain salts and the development of the skeleton in sea-urchin larvæ and sponges are cited.

Moreover, since it is expressly stated in connection with the definition that change of form is not necessarily associated with growth, this section, according to the author's position, has no connection with the main theme of the book, "the determination of the conditions under which changes of form occur" (p. v, preface).

The chapter on "Growth and Regeneration" is not, as its title might lead one to expect, a consideration of the relation between normal and regulatory growth, but a discussion of certain experiments on the rate of regeneration at different levels and the author's pressure-tension hypothesis. Since this is the fullest statement of this hypothesis that Morgan has presented, portions of it are given here in his own words:

What factor determines that the *terminal* organs are those that are first laid down in the new part? . . . A number of considerations, that I can not enter into more fully here, have led me to suspect that this relation of the parts can be accounted for as due to a condition of stratification or polarity, due to the mutual pressure of the parts on each other, which acts as the stimulus for the differentiation of the cells. By these same assumptions we can, I think, also give a fairly consistent explanation of the difference in the rule of growth at different levels (p. 280).

And again in discussing the formation of head and posterior end from anterior and posterior cut surfaces in Lumbriculus he says:

Since the development of these new parts seems to be largely a centripetal phenomenon, we can not assume that the influence of the old part on the new, a centrifugal influence, determines the result; but since the order or sequence of the differentiation in the new part is the same as that in the old part this may determine whether a head or a tail develops. . . . The centripetal influence acting on the new material at the anterior end determines therefore that this is a head, and acting on the new material at the posterior end determines that this is a tail. The centripetal influence is, according to my interpretation, nothing more than the tension of the outer layer of cells and the pressure relations in general, in the rounded dome-shaped mass of new materials. In this way we can give a formal solution of the development of a head in one case and of a tail in the other.

Let us see whether the same hypothesis will explain the different rates of growth of the posterior end according to the level of the cut, as seen in the earthworm, salamander and fish. A growing region is present near, but not quite at,

the tip of the tail. From this region new material is continually being produced, out of which the new part is differentiated. The way in which the new part differentiates is determined by the pressure relation of the neighboring parts. This pressure relation is the result of the differentiation with its concomitant pressure relations, that has already taken place in the old part on the one side and of the tension of the new material at the tip on the other side. The new part differentiates therefore into something that is less than the former and more than the latter. In consequence there will be an ever-decreasing stimulus and differentiation as the new parts are formed, until finally no further stimulus for growth and differentiation is present or is strong enough to act and the growth comes to an end (pp. 280, 281).

To sum up: I have attempted to account for certain phenomena of regeneration by a process of growth in which the following factors appear to enter: (1) the differentiated material as a factor in limiting the character of new parts; (2) the relation of the cells to each other as a factor in their differentiation, and assume that this relation is due to the mutual pressures or tensions of the cells on each other; (3) the differentiated cells also determine the existing tension in that part, and this may in turn react on the new cells with which they are in contact. Remove a part and the pressure relations are upset, but this leads ultimately to the reestablishment again of the same relations of pressure (p. 282).

While space does not permit a critical discussion of this hypothesis, one must admire the author's audacity in putting forward so remarkable a hypothesis without a vestige of evidence to support it. At present his own criticism of Geddes and Thomson's theory of sex seems to apply most aptly:

So vague and general are most of the statements . . . that their interpretation belongs to that class of hypothesis, so common in much of our biological speculation, in which the issue is obscured by the appeal to phenomena as uncertain and little understood as the problems that they pretend to explain (pp. 387, 388).

In the following section, "Experimental Studies in Grafting," the attempt is made to apply this pressure-tension hypothesis to certain phenomena observed in grafts of lower animals. The data presented in this section comprise only a small part of those existing. Only the briefest mention is made of the experiments on the higher vertebrates.

"Experimental Studies of the Influence of the Environment on the Life Cycle" form the subject of the fourth section. Here the influence of food on the life cycle in Lepidoptera, the effect of environment on ripening of the sexual organs, alternation of sexual and parthenogenetic forms in aphids and phylloxerans, the influence of environment on the life cycle in the lower Crustacea, in Hydatina and in the Hymenoptera are considered. The section is merely a résumé of facts and includes much that is descriptive rather than experimental.

The facts and theories bearing on the problem of sex determination are presented in the fifth section. Here, too, there is much that is, properly speaking, not experimental, though of value in consideration of the subject in hand. The factors in sex determination are treated under two heads, the external and internal, food being the only external factor discussed. None of the factors discussed prove certainly upon examination to be real factors in sex determination, for the evidence in all cases is either negative, conflicting or of uncertain value.

In discussion of the relation between the accessory chromosome and sex two possibilities are suggested: the one that the accessory chromosome contains the elementary characters, pangenes, determinants, or whatever we may prefer to call them, of the female sex, the other that it produces its results quantitatively. Morgan points out the difficulties involved in the first alternative and maintains that the second affords a much simpler and more plausible basis for interpretation. He suggests that sex may be determined not in the egg or sperm, but "later by the quantitative relation resulting from the activity of the chromatin in the cells of the embryo." This hypothesis meets difficulties in those cases where the accessory chromosome has a mate of equal size, for here, as Morgan points out, the quantitative difference does not exist.

As a matter of fact, there is a third possi-

bility which Morgan does not mention, viz., that the visible nuclear phenomena, *e. g.,* size and behavior of chromosomes, etc., are results or incidents of processes which are themselves the real determinative factors. If we adopt and consistently maintain a physiological as opposed to a morphological point of view, we are, it would seem, forced to this position.

In conclusion, morphological and physiological conceptions of sex are contrasted, the author favoring the latter:

> The average equality of males and females indicates, I think, that external conditions do not regulate the result, but that some internal physiological mechanism exists that determines the sex. This physiological mechanism does not involve the separation of male and female elements or units in the egg and sperm, but only involves the production of those conditions that determine whether one or the other sex will develop. In some cases the initiatory process may exist in the egg, in others in the sperm, and in still others after the union of egg and sperm (pp. 422, 423).

The final section of the book, on secondary sexual characters, comprises a brief account of the data on the correlation between these characters and the ovary and testis, and a discussion of the theories of the origin of secondary sexual characters.

The book as a whole is largely, as any such book must be, a compilation of facts. The author deserves the commendation of all biologists for his attempt to bring together the scattered data in so many different fields of experimental zoology. But the concentration of material within the limits of a single volume has necessarily resulted in a rather summary treatment of various subjects and entire omission of others. Moreover, since the author has felt himself obliged to omit all consideration of experimental embryology, form-regulation and animal behavior, his consideration of certain subjects is somewhat one-sided. Many of the facts in all these fields have a most important bearing on the problems of heredity and evolution and one which still awaits consideration.

The material which is presented is not always fully digested. Many of the chapters read like a part of some "Jahresbericht" and in many cases the reader is left to go over the data of the experiment and work out the results for himself instead of finding them presented clearly and briefly.

Bibliographies are appended to the various chapters, but no direct references to these bibliographies are made in the text. The disadvantages of this omission are obvious. In many cases also the bibliographies are far from being complete.

As regards the numbering of the figures confusion exists in several cases. Many of the figures are groups of separate figures: the groups are designated "Fig. 1," "Fig. 2," etc., and the single figures are also numbered, beginning with "1" in all cases except in Figs. 3 and 5, where the numbers continue from the preceding figures. In referring to the figures no distinction is made in most cases between the group and the single figure, so that a reference to Fig. 4, for example, may mean either the group Fig. 4 or the single figure 4 in any of the groups. The explanations of the figures make this confusion less serious than it would be otherwise, but some other system is certainly preferable.

Style and method of presentation present certain features which can be due only to haste or lack of care. Repetition is not infrequent; for example, the two following sentences appear within two pages of each other and in reference to the same experiments of Weismann:

> He believed that his observations and experiments show that external factors do not determine the appearance of the sexual generation (p. 337).
>
> Weismann carried out some experiments which show, he thinks, that external conditions do not regulate the alternation of generations (p. 339).

And again in the account of the work of Kellogg and Bell on sex determination in silk-worms these two sentences are half a page apart:

> The chief interest of their work is their examination of the possible effects of nourishment on the second generation (p. 377).
>
> The possible influence of food in determining the sex of the egg (or sperm) was also examined (p. 378).

Various errors in construction seem also to have escaped the author's notice and deserve mention for correction in a second edition:

The order is so different from that given by Yung that, although done on different animals, the interpretation of the real influence of light is probably open to question (p. 264).

He found that when the tadpoles of *Rana temporaria* . . . were fed on a mixed vegetable and meat diet that 95 per cent. of them were females and 5 per cent. were males (p. 381).

The potentialities of producing both sexes is present in all eggs and in all sperm (p. 422).

The development of Cowper's gland seems to be correlated with the development of the prostate and after castration remains undeveloped (p. 436).

With pimprennelle, which also gives an abundant nourishment, but not so well as the preceding, the caterpillars that showed the female type of marking were in excess (p. 437).

Typographical errors are most frequent in scientific names. We find, for example, the following: "pollychloros" for polychloros (p. 16), "fasceata" for fasciata (p. 24), "macchaon" for machaon (p. 29), "ingra" for nigra (p. 34), "rectvoctris" for rectirostris (p. 40), "hortenses" for hortensis (in the explanation of Fig. 15), "*Lymnæa*" for *Limnæa* (p. 263), "nemorales" for nemoralis (p. 273), "*Hormaphs hamamelistes*" for *Hormaphis hamamelidis* (p. 328), "*Hydratina*" for *Hydatina* (p. 348), "*Rhoditis*" for *Rhabditis,* throughout the table on p. 371, and *Rosii* for *Rossi* (p. 374).

Some other typographical errors are: "subjects of 'Formative Reiz'" (p. vi, preface), "25,000 grams" for 2,500 grams as the weight of the adult rabbit, "birth-rate" for birth-weight (pp. 255, 256), "extensive" for extensively (p. 317), "temperate" for temperature (p. 338), "dandylion" for dandelion (p. 380), "capulatory" for copulatory (p. 408), "primoidia" for primordia (p. 421). On p. 374 the specific name "*Rossi*" (spelled *Rosii*) is capitalized, while on p. 438 we find "*fraissei.*"

The book will undoubtedly prove of value especially to the younger students of experimental zoology and to the more general reader who desires to know something of the work that has been done along these lines.

C. M. CHILD

Chemical Pathology. By H. GIDEON WELLS. Philadelphia, W. B. Saunders Co.

While only a comparatively short time has elapsed since the appearance of Virchow's "Cellular Pathology," yet it is significant of the steady progress of pathology that meanwhile new and infinitely finer means for its advancement have been developed and many new fields within its territory have been opened to investigation.

The cell is essentially chemical in its functions. Normal and pathological processes as well as bacterial influences in their relation to higher forms present so many problems that can be solved only by chemical agencies and explained only in chemical terms, that any book dealing adequately with chemical phases of pathology offers an important addition to the means at hand for acquiring a mastery of the subject.

In his "Chemical Pathology," Professor Wells addresses himself to three classes of readers: the student of medicine, the physician and the investigator, but it seems evident, as one reads his book, that it is the medical student whose interest he has sought chiefly to attract. For reference reading on the chemical side of pathology in the same way that the student would use his Orth for morphology, the book is well designed. The exposition of fundamental chemico-pathological changes, such as inflammation, cell necrosis, etc., is clear and concise, and is well designed to enable the student to grasp a larger concept of pathology than he could well obtain without such an aid. Of the chapters dealing with the problem of immunity one may not speak so unreservedly. The elucidation of the theories and the experimental evidences pertaining to that extensive subject are not so well put as in some other works of this kind. It is also to be regretted that in dealing with the problems of bacteriology the author did not go into the physical chemistry of the subject in more detail—a field that has become particularly fruitful, in recent years, in its yield

of data pertaining to all phases of chemical biology.

The clinician will find in Professor Wells's book not only much that is very instructive, but also, if he be so minded, much that will stimulate him along lines of individual investigation. The chapters devoted to the diseases of metabolism, such as diabetes, while less exhaustive than they might be, are excellent in the compact, condensed style in which they are written. Preceding the study of each disease is given a short description of the chemistry of related normal metabolic changes and the various pertinent theories of importance. It is a question whether future editions of Professor Wells's book might not be improved if more space should be devoted to such diseases as gout than they receive in this edition. While it is true that there are exhaustive works on such subjects, Minkowski's, for example, they are not much read by practising physicians nor by students, perhaps because they are too full of details, while a book like Professor Wells's is almost sure to be in large demand.

One is often led to wish that the author were less reticent in stating his own ideas relative to many questions. The writer of a book like this steps out of proximity to any one problem and, by virtue of his apartness, he is apt to have a correct perspective of the results of its investigation and of the relations that such results bear to each other and related data. From such a vantage point, the criticisms of a man who has himself been a laboratory worker are valuable to student and investigator alike. As Professor Wells says, what the investigator in scientific fields most requires is effective guidance, and ready access, to original publications. The excellent bibliography in the book under discussion affords that.

When one considers the extent of the field that must be covered by a book dealing with chemical pathology, it is surprising to note the large amount of matter that Professor Wells has compressed into a relatively small volume. It is our opinion that the demand for Professor Wells's book will be a cumulative one and that his successful authorship will induce him to include, in future editions, discussions of various additional pathological matters of importance that could not be encompassed in the original volume.

NELLIS B. FOSTER

COLUMBIA UNIVERSITY,
November 18, 1907

Physiography. By ROLLIN D. SALISBURY. American Science Series—Advanced Course. New York, Henry Holt and Company. 1907. Pp. 770, plates, figures, maps.

Object.—As Professor Salisbury states in the preface of his "Physiography," the book is intended for students of early college or normal school grade who have received elementary instruction in the subject, but who do not expect to pursue the study further. There are a number of text-books on this subject which have been published from time to time within recent years but none of them has been devoted especially to this class of students. Professor Salisbury's book, therefore, meets a real want and the character of its compilation, based as it is, on many years of experience in teaching, gives the book a completeness far beyond any other physiography published up to this time.

Plan.—The book is a companion volume to "Geologic Processes" which appeared in 1905, and much the same plan of treatment is adopted in both. In the "processes" the emphasis is thrown on the discussion of the agencies which have brought about changes in the earth's crust. In the "Physiography" topographic forms are brought into greater relative importance and less discussion given to the processes which have produced them. Part I. is devoted to the Lithosphere, part II. to the Earth Relations, part III. to the Atmosphere, part IV. to the Oceans. Each one of these major divisions is subdivided into appropriate chapters.

Illustrations.—The "Physiography" is as fine an example of text-book making as has yet appeared on the subject, and it is difficult to see where it could be improved. The figures which are both halftones and line engravings, are well selected, numerous, and beautifully reproduced. The maps are in great measure

lithographs, in three colors, of typical localities within the United States. Such charts as are used to illustrate weather conditions are well selected. Nearly every phase of the subject has its appropriate figure or map to aid the student in gaining a correct idea of the matter in hand.

Exercises.—One of the most important features of the book is the portion devoted to original exercises at the end of each chapter. By the use of these exercises the student is induced to think for himself and apply what is discussed in the text. As far as is practicable the student is led up into the subject rather than led down out of it. Numerous well selected references are given. These serve a double purpose. Not only do they place the student in touch with more important publications bearing on the subject but they also furnish a list of books which might well be placed in every school library for the use of science teachers. It is a gratification to have such a text-book to work with and it will be appreciated by every teacher of physiography.

GEORGE BURBANK SHATTUCK

SOCIETIES AND ACADEMIES

THE NEW YORK ACADEMY OF SCIENCES—SECTION OF GEOLOGY AND MINERALOGY

AT the first regular meeting, October 7, 1907, the following papers were read:

On the Pebbles at Harwich (Cape Cod), Mass., and on Rude Arrow-heads found among them: DR. ALEXIS A. JULIEN.

Along the south shore of the apron-plain at Harwich the glacial deposits show abundant sections of layers of gravel, often coarse, and at one point huge angular boulders, up to eight feet in diameter, similar to those in the moraine along the north side of the cape. The pebbles consist almost altogether of crystalline rocks in considerable variety, in which, however, three types predominate. The principal one is a coarse binary granite, sometimes porphyroidal, passing by addition of hornblende into monzonite. Its sheared form seems to be represented by pebbles of granite-gneiss or aplite-schist, without mica, and very rarely of a fine biotite gneiss.

This rock appears to have been cut by intrusive dikes, both of an acid rock and of another of intermediate character, occurring in abundant pebbles. The one is a pinkish quartz-porphyry, a white felsite or finely striped rhyolite, whose sheared form appears to be a white phyllitic gneiss, with minute augen-structure. The other, a rather finely granular gabbro, made up of white feldspar and a greenish black hornblende-like mineral. This rock by shearing has passed into a hard greenstone, often decidedly schistose, and perhaps into a banded schist. Besides these three types, several varieties of fine crystalline schists, probably metamorphic; rarely small grains of serpentine; and occasional flakes of blue-black argillite. A marked feature in all these rocks is the almost entire absence of mica of any kind and that mineral does not occur even in the sands and clays, at least in scales visible to the naked eye.

By contrast, the characteristic rocks of the adjoining coast along the mainland of eastern New England have not been found, in spite of constant search, *e. g.*, the mica-gneisses and mica-pegmatites north of New Bedford, the granite of Quincy, Mass., the Dorchester conglomerate, the pyroxenic rocks and basic mica-diorites of Nahant, the porphyritic biotite granites of the Maine coast, etc. The conclusion is that the pebbles at Harwich have been transported from some other mica-less region.

Among the pebbles in ploughed fields many rude stone implements may be found, such as tomahawks, scrapers, lance-heads, and particularly arrowheads of the simplest form, probably left by Indians of the Massaquoit tribe, of whom several small kitchen-middens have been found in the neighborhood. These tools have been made from the local materials above described, chiefly from pebbles of the harder and finer schists, rhyolite, quartz-porphyry and often granite. Their dull edges and rounded points may imply that in many cases they have never been sharpened, but used for stunning birds and small animals. Many

show mere traces of human workmanship, perhaps but one or two artificial faces, as if their owners had been content to use the simplest flakes for arrow-points.

The Sylvania Sandstone—A Study in Paleography: Dr. A. W. Grabau.

The speaker described field work carried on in company with Professor Sherzer in southern Michigan for the state survey. The special object of study was the Upper Monroe formation and the Sylvania sandstone. The evidences of the eolian (anemoclastic) origin of this rock were presented. An interesting new fauna of late Siluric age and with Devonic affinities was found in the higher beds. Evidence of the disconformable relation of the Monroe and the overlying Dundee (Onondaga) was obtained.

After discussion of both papers, the members of the section contributed observations made during the summer. Professor J. F. Kemp stated the general results of study of the petrography of the Adirondack region, and Dr. E. O. Hovey gave an account of excursions of Section E of the American Association for the Advancement of Science in the vicinity of the Adirondacks. Professor C. P. Berkey reviewed his recent investigations in the Highlands of New York, the difficulty of correlation of the Manhattan schists on the south with the Cambrian sedimentaries on the north, but reported the passage of the latter into crystalline condition eastward toward the Connecticut line.

Alexis A. Julien,
Secretary

THE AMERICAN MATHEMATICAL SOCIETY

The one hundred and thirty-fifth regular meeting of the society was held at Columbia University on Saturday, October 26, a single morning session sufficing for the usually brief program. The attendance included twenty-eight members. Vice-president P. F. Smith occupied the chair. The council announced the election of the following persons to membership in the society: V. R. Aiyar, Gooty, India; P. P. Boyd, Hanover College; Charles Haseman, Indiana University; C. A. Proctor, Dartmouth College; I. M. Rysgaard, University of North Dakota; C. A. Toussaint, New York City College. Thirteen applications for membership were received. A list of nominations of officers and other members of the council was adopted to be placed on the ballot for the annual meeting.

The following papers were read:

R. D. Carmichael: "A certain class of quartic curves."

R. D. Carmichael: "Geometric properties of quartic curves possessing fourfold symmetry with respect to a point."

Oswald Veblen: "On magic squares."

L. E. Dickson: "On triple algebras and ternary cubic forms."

G. H. Darwin: "Further note on Maclaurin's spheroid."

J. T. Coolidge: "The equilong transformations of space."

Edward Kasner: "Note on isothermal systems."

R. L. Moore: "A note concerning Veblen's axioms for geometry."

Joseph Bowden: "Proof of a formula in combinations."

The annual meeting of the society, at which the annual election of officers takes place, will be held at Columbia University on Friday and Saturday, December 27–28. The Chicago Section will meet on December 30–31, in affiliation with the American Association for the Advancement of Science. The annual meeting of the Southwestern Section was held at St. Louis on November 30.

F. N. Cole,
Secretary

THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON

There was presented at the meeting of November 5, 1907, a report on "Recent Explorations and Excavations in Colorado, Utah and New Mexico," by Edgar L. Hewett, director of American archeology for the Archeological Institute of America. The paper was illustrated with lantern slides. Professor Hewett was able, with the aid of volunteer students, to carry on an extensive reconnoissance of ruins on the San Juan River in Utah and Colorado, and interesting views were

shown of this work in Mesa Verde Park, McElmo Canyon, Monument Park and Grand Gulch, the latter containing several hundred cliff-dwellings of the "Basket Makers." The work in New Mexico was concentrated on a large ruin in the Puye, where 120 rooms were cleared out and a collection secured numbering 3,500 artifacts. The paper was discussed by the president, Dr. Hrdlicka, and Mr. Robinson.

WALTER HOUGH,
General Secretary

THE CHEMICAL SOCIETY OF WASHINGTON

THE 177th regular meeting of the Chemical Society (Washington Section) convened at the Cosmos Club, November 14, at 8 P.M., President Fireman presiding. Two councilors, L. M. Tolman and F. K. Cameron, were elected to represent the section at the general meeting of the society.

The following paper by C. A. Crampton and L. M. Tolman, "The Changes taking Place in Whiskey during Storage in Wood," was read by Mr. Tolman. Graphic illustrations showed the chemical changes in whiskey during nine years' study. The attendance was about eighty.

J. A. LECLERC,
Secretary

DISCUSSION AND CORRESPONDENCE

THE HOLOTHURIAN IN DREW'S INVERTEBRATE ZOOLOGY

THE laboratory guide written by Dr. Gilman A. Drew with the aid of members of the zoological staff of instructors of the Marine Biological Laboratory at Woods Holl, like its predecessor by Dr. Bumpus, has many excellent features. Since it is probable that a number of teachers will place this work in the hands of their students before a new edition can be issued, I venture to make a few suggestions concerning the description of *Thyone*, the type representing the Holothurioidea.

On page 69 the paragraph numbered 2 relates that "Ten forwardly directed canals leave the water-ring and pass into the tentacles." Some of the older text-books affirm this error, while others do not state clearly the origin of the tentacles but most of the newer works on zoology like Parker and Haswell, Delage and Hérouard, Goodrich in Lankester, Lang and others properly describe the tentacular canals arising from the *radial canals*. Ludwig, in 1891, demonstrated in the embryology of *Cucumaria planci* that the tentacles arise from the radial canals and not, as previously given, from the circular canal (water-ring). The student should be directed to inject the water vascular system with Ranvier's Prussian blue through one of the Polian vesicles. After cutting away the œsophageal wall he can see the tentacular canals branching from the radial canals just before the latter bend over the radial pieces of the calcareous ring. He will thus understand that the tentacles are simply modified pedicels.

Since in the study of holothurians it is important to distinguish the ambulacral appendages with suckers, as *pedicels*, from those without, as *papillæ*, it would be better, on page 67, to substitute *cylindrical pedicels* for "papilliform ambulacral suckers." The term sucker could then be limited to the terminal sucking disc.

Under Digestive System (p. 68) *the calcareous ring* should be substituted for "a cartilaginous structure."

Under Reproductive System (p. 68) the gonad should be described as made up of two brushes, one on either side of the dorsal mesentery.

It is to be regretted that no mention is made of the paired bands of longitudinal muscles, so characteristic of holothurians, and of the five powerful retractor muscles possessed by *Thyone* and the other members of the family Cucumariidæ. For comparison with the skeleton of the other Echinoderma described by Drew something should be said of the spicules, in the form of *tables*, found in the walls of the pedicels of *Thyone*. The student can easily examine these spicules under the microscope after placing a few pedicels in caustic potash for a short time.

CHARLES L. EDWARDS

THE "CENSUS OF FOUR SQUARE FEET"

CONCERNING Nathan Banks's recent notice[1]

[1] SCIENCE, N. S., XXVI., p. 637.

of the article[2] on a "Census of Four Square Feet," the writer desires to state that he had hoped to anticipate such criticism by the statement in the opening paragraph that the results detailed are not held applicable to any classes of surface other than those examined. The scope of the article was further restricted by noting that all of the material was collected in winter months (November and March), on the surface of the ground and in the ground itself to the depth a bird can scratch. Moreover, the limits of the inquiry were again emphasized in next to the last paragraph, where it is referred to as an investigation of the surface fauna. In view of these facts, my statement that the population of the meadow is much more dense than that of the woods should not have been misinterpreted. By frequent reference to the special character of the investigation it was intended to leave no doubt that a survey was attempted of only the surface life. Hence all of Mr. Banks's comment on the fauna of above-ground growths, while interesting as showing what would be the nature of a census including these objects, has no bearing on the subject in hand.

Mr. Banks says of meadows and woodlands: "the two regions are so variable that a comparison from selected spots has little significance." The use of the term "selected" here is unfair, as it applies only in the sense that necessarily some spot must be chosen (indeed the plot of forest floor was designated by another person), but it is not more unfair than the efforts made to discredit the results of the "census," by instances every one of which in a very special sense is selected. Each instance, moreover, characterizes the summer, not the winter fauna, which alone was studied. For these reasons the writer fears that Mr. Banks has a mistaken conception of the paper he criticizes.

W. L. McAtee

[2] Science, N. S., XXVI., pp. 447–449.

PROFESSOR ANGELO HEILPRIN AS AN ARTIST

To the Editor of Science: The Pennsylvania Academy of the Fine Arts has at present on exhibition eight oil paintings by the late Professor Angelo Heilprin. Their subjects are: The Ash Cloud; Mont Pelé and the Ash Cloud; Looking into the Crater, June 1, 1902; The Tower of Mont Pelé; Mont Pelé in eruption with a graveyard in the foreground; A View into the Crater; An Eruption; Afterglow on the Ash Cloud.

Scientists undoubtedly know how much good work Heilprin accomplished in exploration, in natural history, in geography and in geology. But few of them realize as yet that Heilprin was a great landscape painter.

His painting is distinctly art, the art of a painter, not the art of a scientist. His pictures are not diagrams, they are not illustrations of any science—they are purely color records, memory sketches of phases of nature, which in the case of some of these Mont Pelé pictures, he saw at the risk of his life.

He seems to have had the technique of oil painting at his fingers' ends: his drawing is good: values understood; gradation of light and atmospheric perspective accurate: the quality and handling of the paint masterly.

These eight pictures, grouped together on one wall, have a jewel-like glow of color. They are all more or less in somber tones, except the Tower of Mont Pelé. Clouds, fire, darkness, smoke, have never been so painted before. And all of these pictures have the first and underlying art requisite—beauty.

It would be a boon to science and a boon to art, if these pictures could be kept together, and placed either in the American Museum of Natural History or the United States National Museum.

Edwin Swift Balch

Philadelphia,
November 23, 1907

BADGES AT MEETING OF THE AMERICAN ASSOCIATION

To the Editor of Science: The prospectus for the forthcoming meeting of the American Association for the Advancement of Science is now out. Will you allow me a few words in Science?

To me, and probably likewise to a large part of the attendance, meeting friends and seeing eminent men is very attractive. We gather very largely for this purpose—to see and be seen. At the meetings in Indianapolis

and Washington, the last ones I attended until recently, it was very easy to find out who were present from day to day, and generally possible to identify each member. The contrast in this respect was very great in New York last winter. It was very difficult, if not impossible, to learn who were in attendance, and equally to identify the members—quite a disappointment to me and I feel sure also to others. When I saw how things were at this meeting I asked a seemingly energetic member standing by me: "Wherefore this trouble? Why not post an alphabetical list in a conspicuous accessible place on the wall so we can tell, all of us, at a glance who are here." He seemed quite pleased with the idea and asked me why I did not patent it. I took this reply seriously until I learned that my companion was the learned permanent secretary of our association and then I saw he was poking fun at me, for how absurd to think there could be improvement on what such a man arranged! Perish the thought!

Our identification by buttons was very unsuccessful, apart from the absence of a list of names; the figures were far too small for most eyes. In fact the inability to make out the figure on a button placed me in the above absurd position of criticizing the management to our learned secretary himself. Moreover, the buttons were not quite fairly distributed. I came early and was assigned a low number, below fifty, I think, but I could not get that button throughout the whole meeting though I applied for it every day. I saw plenty of higher figures, way up into the hundreds. Members arriving much later were served much more promptly. Why not have the numbers on ribbons with large conspicuous figures, say scarlet ground and one inch black figures. These we could see. Then if in addition a daily list of members present were distributed, I for one should find happiness right at this part of the meeting, but I fear on account of the expense—what are our dues for—and because I see in the notices sent out that no daily program will be issued, I shall have to seek happiness elsewhere.

Clarence L. Speyers

Rutgers College,
New Brunswick, N. J.

SPECIAL ARTICLES

ON THE DISCOVERY OF REPTILIAN REMAINS IN THE PENNSYLVANIAN NEAR PITTSBURG, PENNSYLVANIA

In the vicinity of Pittsburg, the Ames Limestone rests upon a bed of almost structureless red and green clay which forms the upper part of the Pittsburg Red Shale. The thickness of this bed varies, but usually ranges from eighteen to about forty feet. At a locality about one mile west of Pitcairn and fifteen miles east of Pittsburg, the writer was fortunate enough to obtain a number of bones which appear to represent the remains of animals of at least two groups, namely: theromorph reptiles, and amphibians.

In this preliminary notice it is intended merely to describe these bones in a general way, and to show the stratigraphic position of the bed in which they were found. The bones have been examined and provisionally identified by Professor E. C. Case and Dr. W. D. Matthew, to whom my thanks are due. A detailed description of these fossils will be given by Professor Case in the forthcoming number of the Annals of the Carnegie Museum.

The "Crinoidal" (Ames) Limestone of western Pennsylvania is the youngest of the fossiliferous limestones of marine origin in that region, and is located at about the middle of the Conemaugh Series (Lower Barren Measures). In the vicinity of Pittsburg it lies 315 feet below the Pittsburg coal. At Pitcairn, the section extends but a short distance above the Pittsburg coal, but in the more complete sections farther south, the Monongahela Series, about 380 feet in thickness, overlies the Conemaugh. Above the Monongahela Series is the Dunkard Series, usually referred to the Permian. The horizon of the vertebrate fossils is at least 725 feet below the base of the Permian (Dunkard Series), and about an equal distance above the top of the Mississippian.

At Pitcairn the red clay beneath the Ames Limestone is 37 feet in thickness. Three feet above the base is a layer of somewhat nodular limestone, full of small worm-tubes (*Spirorbis carbonarius* Dawson). The teeth of the diadectid reptile described below were weathered

out, and found lying on this layer of limestone where it projects from a rather steep bank at the roadside. All of the other bones were found imbedded in the clay about a foot above the layer of limestone, and about ten feet from the spot where the teeth were lying. All the bones were at the same level, and were recovered from an area about three feet in length and one foot in width.

The bones are in a good state of preservation and though somewhat brittle, are easily freed from the rather soft clay matrix. Many of the bones are fragmentary, apparently having been broken before they were imbedded. Very few of them are distorted, though the clay which contains them is full of slickensides. No other fossils have yet been found in this bed. About twenty-five entire or fragmentary bones have been found. The most complete are an ilium, some ribs, and the pleuro-centra, hypocentra, and neural arches of vertebræ of the rachitomous type. All these appear to belong to amphibians, probably much like *Eryops*, from the Permian of Texas.

The reptilian remains consist of several chevrons, and a fragment of a jaw containing four small transversely elliptical, long-rooted teeth. These are evidently from a reptile belonging to the family Diadectidæ.

Age of the Beds containing the Vertebrates.—The Ames Limestone is not a local stratum, but can be "traced from Central West Virginia in Lewis County northward into Pennsylvania and continuously through Greene, Westmoreland, Allegheny, and Beaver Counties into Ohio, whence it can be followed without a break across that state to where it reenters West Virginia near Huntington in Cabell County, to disappear finally under water level at the Kentucky line in Wayne County, eight miles above the mouth of the Big Sandy River" (West Virginia Geological Survey, Vol. II., p. 259). The red clay and shale below the limestone seem to be coextensive with it. There is therefore no doubt of the position of the bed containing these fossils.

All of these vertebrates have evident affinities with Permian species, no reptiles having been found in strata known to be older than the Permian. Similar fossils have been found in beds on the border line between the Permian and the Carboniferous on Prince Edward's Island, and in Illinois, Kansas, New Mexico and Arizona. The formations containing the reptiles in those localities have been referred to the Permo-Carboniferous (*i. e.*, the base of the Permian).

The Conemaugh series of southwestern Pennsylvania has always been considered as Upper or true Carboniferous. Recently Dr. I. C. White has suggested that the Monongahela Series and that part of the Conemaugh Series above the base of the Buffalo Sandstone, should be removed from the Carboniferous and placed in the Permo-Carboniferous. He cites in favor of this action a change in the fauna and flora, and the introduction into the section of "red-beds" above the base of the Buffalo Sandstone (West Virginia Geological Survey, Vol. II., 1903).

The discovery of reptiles in the Pittsburg Red Shale, at a horizon about 150 feet above the base of the beds ascribed by Dr. White to the Permo-Carboniferous, presents an argument in favor of this suggestion. It should be noted, however, that the remains so far found indicate smaller and more simple animals than those found in the Permian of Texas, and thus suggest their somewhat greater antiquity.

The evidence obtained from the invertebrate fossils of the Conemaugh Series, so far as they have been studied, is not of great value in the correlation of these beds, for the fauna consists mostly of long-lived species.

No distinctly Permian fossil plants have yet been found below the Dunkard Series, and the preponderance of the evidence at the present time seems to be in favor of regarding the Conemaugh Series as Pennsylvanian.

Percy E. Raymond

Carnegie Museum,
November 19, 1907

THE TUSKS AND SIZE OF THE NORTHERN MAMMOTH

The last report of the Smithsonian Institution is accompanied, as has become customary, by an "appendix" consisting of a selected number of scientific papers of very general in-

terest. One of these, by E. Pfizenmayer, deals with the northern mammoth and while very interesting, contains what I believe to be two very serious errors. The first one of these relates to the shape of the tusks, which are discussed at considerable length, the author concluding that the tips pointed forwards and downwards and were used in digging. To support this contention we are given figures of several tusks and a copy of a drawing in a cave at La Mouthe.

It seems a sufficient reply to this last bit of testimony to note that there are many other figures of the mammoth in existence, including various carvings, and in none of these are the tusks depicted as shown in the cave of La Mouthe.

Tusks of the mammoth exist in Alaska in large numbers and many have been brought from there during the past few years. None of them shows the great spiral twist and final downward curvature of the tusks figured by Dr. Pfizenmayer. Tusks of the mammoth, like those of the mastodon, vary very greatly in the amount of curvature and of their spiral twist. As a general rule the curvature is at first downwards and outwards, and then upwards and inwards. The tusks figured by Dr. Pfizenmayer are very evidently those of old individuals and are abnormal in shape. The tusks of the Beresovka mammoth do not exhibit the great spiral curvature of the specimen from Cracow and there is no reason to believe that, *as a rule,* the tusks of the mammoth pointed downwards and forwards. When in exceptional cases they did, it would be quite natural to use them for digging.

The second error is in ascribing to the northern mammoth a greater size than that of existing elephants. Unless I am mistaken, no Siberian mammoth has yet been found having greater height at the shoulders than nine feet six inches, a height occasionally equalled by the Indian elephant and exceeded by the African species, which stands eleven feet high and occasionally slightly more at the shoulders. Dr. Swanton, indeed, has recently recorded a specimen of the Indian elephant having a height of eleven feet, but this seems somewhat questionable. It must not be forgotten, however, that few elephants are allowed to reach their full age and size, much less to develop tusks of the greatest possible length, and this partly accounts for the comparatively small size of the tusks of modern elephants.

There is no tusk of the northern mammoth in existence so heavy as the heaviest examples of tusks of the African elephants and there are few tusks much longer than the greatest recorded length found among this species. The tusks of the northern mammoth average somewhat longer than those of either of the existing species of elephants, but they did not reach so great a diameter as the best specimens of tusks of the African elephant which measure from nine feet to eleven feet six inches long and weigh from 125 to 239 pounds for a single tusk.

It has frequently been shown that the northern mammoth was no larger than existing elephants, as a matter of fact it did not stand so tall as the Soudan elephant, but it seems difficult to effectually dispose of the belief that it was a creature of gigantic size.

The true giants among fossil elephants are *Elephas meridionalis* of southern Europe and *E. imperator* of our western and southwestern states, which stood from twelve feet six inches to possibly thirteen feet six inches high.

F. A. LUCAS

CURRENT NOTES ON LAND FORMS

A PENEPLAIN IN THE GRAND CANYON DISTRICT

THE existence of an uplifted and dissected peneplain in the Grand Canyon district of Arizona has been recognized for some years, and its relation to the great folds and faults of the region has afforded a subject for interesting discussions. Little has been known in detail, however, regarding the peneplain remnants. Dr. H. H. Robinson, of Yale University, recently offered a contribution to this subject in an account of "The Tertiary peneplain of the Plateau district, and adjacent country, in Arizona and New Mexico" (*Amer. Journ. Science,* XXIV., 1907, 109–129). He concludes that after the occurrence of the principal displacements the greater part of the region was reduced to a peneplain "of practically no relief." The broad uplift of

this peneplain has given opportunity for the deep erosion of the Colorado canyon, and for a moderate dissection of the weaker parts of the uplifted area. Presumably before the time of uplift, wide-spead eruptions of basalt occurred in the southern part of the area; it is to the capping of lava thus supplied that remnants of the peneplain are preserved in the localities studied by the author. At Black point in the Little Colorado valley, a monoclinal fold involving compact sandstone and weak marls is bevelled across by a very perfect plain of erosion, upon which the basaltic cover rests. In Anderson mesa, southeast of Flagstaff, Arizona, a lava cap rests upon a similar smooth surface, which bevels across slightly inclined beds of resistant Upper Aubrey limestones and weak overlying shales. The lava sheet of Black mesa rests upon Upper Aubrey limestones and sandstones along the western border of the mesa, but upon the overlying red beds farther east, thus indicating a bevelling similar to that of the other examples. Other localities afford evidence of the same kind. The several peneplain remnants thus identified are believed to represent parts of a once continuous and extensive peneplain. Lava-capped baselevelled surfaces in the Mt. Taylor district of New Mexico farther east and in the Basin region of Arizona farther west, are correlated with the great peneplain of the Grand Canyon district.

The latter part of the paper is concerned with a discussion of the drainage system of the plateau district, with the conclusion against the antecedent origin of the Colorado River. There is much to be said in favor of this conclusion, but the author's arguments for it appear much less cogent than those already cited regarding the peneplain.

D. W. J.

THE ISTRIAN PENINSULA

An elaborate study of the Istrian peninsula at the head of the Adriatic by Dr. Norbert Krebs of Vienna ("Die Halbinsel Instrien: Landeskundliche Studie." Geogr. Abhandlungen herausg. von Professor Dr. A. Penck in Berlin—formerly Vienna—Band IX., heft 2, 1907) shows that it is a good-sized block broken out of a well-worn-down mountain system of close-folded Mesozoic limestones and Tertiary sandstones with northwest-southeast trend. A pretty good peneplain was formed on the limestones, while the sandstones were reduced to low rounded hills and ridges; then the Istrian block was uplifted and tilted westward, with a strong fault along the eastern (Quarnero) border; and in this position it was submaturely or maturely dissected in later Tertiary time, with abundant development of karst features on the limestone areas; recently the dissected block has been somewhat depressed, so that the sea now enters its lower valleys in river-like bays.

To European geographers, who are already familiar with these facts, Krebs' essay will be easy and profitable reading, by reason of the great body of pertinent details that it presents concerning matters of structure and form. But to more distant readers, many of whom must be unacquainted with the local names and the physiographic history of the peninsula, the essay will be difficult reading, because the explanatory descriptions of the larger features are almost lost in the wealth of details concerning the minor features. Only after reading nineteen pages, most of which are given to geological matters, does this geographical essay state the elementary and essential fact that the surface of the peninsula is not a structural ("geological") surface, but the final work of a process of abrasion (das Endergebnis eines Abrasionsvorganges); not until the twentieth page is the inner and higher part of the peninsula explicitly described as a monotonous plateau, surmounted by rounded and isolated hills and ridges; and not until the thirty-fourth page is the lower western part of the peninsula stated to be a slightly arched abrasion surface, which may be regarded as a less elevated extension of the higher eastern part.

W. M. D.

STRUCTURE, PROCESS AND STAGE

It would be an immense assistance to the distant reader—and perhaps an aid to some nearer readers as well—if substantial physio-

graphical essays were opened with a brief general statement, giving the essence of the whole story in terms of structure, process and stage of development; and if the later pages then proceeded, following the scheme and the sequence thus outlined at the beginning, to present the details. The Istrian peninsula would seem to lend itself admirably to such treatment. Its larger structures are reducible to a very simple statement, upon which all sorts of details as to pitching folds and overthrusts may be afterwards embroidered. The deformed mass without question reached well-advanced old age in the first recognizable cycle of erosion, as is clearly indicated by the even surfaces which transect the folded strata over large areas. It is equally evident that irregular movements of faulting and tilting interrupted the first cycle before the more resistant strata were completely worn down. In the new cycle thus introduced revived erosion gained a good advance, with characteristic development of karst features on the limestones, before a moderate submergence drowned the borders of the dissected block at so recent a date that the present shore line is still very young. Upon the framework of such a statement all details can be most conveniently placed in good order for easy understanding; but if no general framework is presented at the beginning, the reader must be embarrassed as he comes on page after page of unrelated details.

There is, however, a certain unevenness of treatment in Krebs' essay on the Istrian peninsula which seems to indicate that the author is perhaps not yet ready to adopt the concise scheme of "structure, process and stage," above suggested. The even uplands are repeatedly spoken of as the work of "abrasion," thus implying that the first cycle of erosion was accomplished chiefly by marine processes; yet there is no discussion of this debatable point; it appears to be accepted as a traditional truth; and this in spite of the frequent occurrence of rounded residual reliefs which surmount the uplands and which are much more suggestive of subaerial than of marine erosion in the first cycle. Furthermore, while no sufficient space is given to an adequate discussion of the origin of the chief features of the peninsula, space is allowed (p. 66) for a brief refutation of the obsolete ideas that the typical drowned valleys on the west and south (Canali di Leme and dell' Arsa) are due to (marine) abrasion or to faulting. There is no need of such a refutation; but there is much need of a critical consideration of the postulated marine planation of the district.

W. M. D.

THE TWENTY-FIRST SESSION OF THE MARINE BIOLOGICAL LABORATORY, JUNE 1 TO OCTOBER 1, 1908. PRELIMINARY ANNOUNCEMENT

ON account of considerable changes proposed for the season of 1908, the following preliminary announcement is made. Attention is directed particularly to the statements concerning the addition of the Wistar Institute of Anatomy and Biology to the list of cooperating institutions, to the change of personnel in the staff of instruction in zoology, to the reinstatement of the course in embryology and to the introduction of a new course in the general morphology of plants. The final announcement will be ready in March or April, 1908, and will be sent on request to all desiring it.

The Marine Biological Laboratory is an institution for the promotion of research in biology by the cooperative endeavors of biologists from all parts of the country. The laboratory is a national institution on an absolutely independent foundation, and it solicits the cooperation of all students of biology.

I. *Research.*—The laboratory will be open for research from June 1 to October 1, 1908. Facilities for research are offered in zoology, embryology, physiology and botany. Fifty-five private rooms are reserved for investigators, and those assigned to such rooms are supplied with reagents, glassware and service in the collection of material. The majority of these rooms are reserved for members of the staff and for subscribing institutions. The charge for the remaining rooms is $100 per season and applicants should state the time of desired occupancy and any special needs;

application should be sent to the assistant director (Frank R. Lillie, University of Chicago) before May 1.

Subscribing institutions for the year 1907 were as follows:

Academy of Natural Sciences, Philadelphia.
Bryn Mawr College.
Mount Holyoke College.
Rochester University.
Smith College.
Syracuse University.
University of Chicago.
Columbia University.
University of Pennsylvania.
University of Cincinnati.
Vassar College.
Wellesley College.
Woman's College of Baltimore.
Kansas University Woman's Table supported by Mrs. Robinson.
Vassar Brothers' Institute.
University of Michigan, Bryant Walker Scholarship.
United States Department of Agriculture.

It is hoped that this list may be increased. The laboratory carries out work of interest and importance to all biological departments, and provides facilities for marine work that would cost such departments acting independently many times the rental of a room at the Marine Biological Laboratory. Institutions that favor this cooperative plan are requested to aid by subscribing for rooms, prices for which are $100 per season. The subscription carries with it the right of nomination of the occupant of the room, who receives services and supplies as stated above.

An important addition to the list of cooperating institutions for 1908 is the Wistar Institute of Anatomy and Biology, which subscribes for five rooms. Four of these are available for qualified investigators in anatomy and zoology. Applications may be sent directly to the Wistar Institute of Anatomy and Biology, Philadelphia, Pa., or to the assistant director of the Marine Biological Laboratory.

The staffs of the various departments constitute a permanent nucleus of investigators and center of interest for research in all departments. It is expected that the research staffs in zoology and physiology will be substantially the same as in 1907, viz.:

ZOOLOGY

E. G. Conklin, professor of zoology, University of Pennsylvania.

C. W. Hargitt, professor of zoology, Syracuse University.

George Lefevre, professor of zoology, University of Missouri.

Warren H. Lewis, associate professor of anatomy, Johns Hopkins University.

Frank R. Lillie, professor of embryology, University of Chicago.

T. H. Morgan, professor of experimental zoology, Columbia University.

C. O. Whitman, professor of zoology, University of Chicago.

E. B. Wilson, professor of zoology, Columbia University.

PHYSIOLOGY

Albert P. Mathews, professor of physiological chemistry, University of Chicago.

E. P. Lyon, professor of physiology, University of St. Louis.

Ida H. Hyde, professor of physiology, University of Kansas.

R. S. Lillie, instructor in comparative physiology, University of Pennsylvania.

A. J. Carlson, assistant professor of physiology, University of Chicago.

Edward G. Spaulding, assistant professor of philosophy, Princeton University.

Oliver P. Terry, instructor in physiology, Purdue University.

Horatio H. Newman, instructor in zoology, University of Michigan.

BOTANY

The research staff in botany for 1908 will include the following:

John M. Coulter, professor of botany, University of Chicago.

B. M. Duggar, professor of plant physiology, Cornell University.

Henry Kraemer, professor of botany, Philadelphia College of Pharmacy.

George T. Moore, Water Mill, New York.

Hermann von Schrenk, pathologist, Missouri Botanical Garden.

Erwin F. Smith, in charge of Laboratory of Plant Pathology, United States Department of Agriculture.

M. B. Thomas, professor of botany, Wabash College.

A limited number of private rooms is available for other investigators in botany. Applications for use of these rooms should be made to Dr. George T. Moore, Water Mill, New York.

Subjects for investigation in zoology, physiology or botany will be assigned to those whose previous training qualifies them to begin research. The student may select his teacher in investigation, subject to the approval of the latter.

II. *Instruction.*—The courses of instruction are six weeks each, including about four weeks in July and two in August. Each course requires the full time of a student. They are so graded that the student may supplement his college instruction by courses leading up to research, or he may take the more elementary courses in zoology or general morphology of plants. Credit for courses taken in the Marine Biological Laboratory is generally given by colleges and universities and also by boards of education of various cities, on certificate of the instructor in charge. It has been decided to add two courses to those given in recent years, viz., a course in embryology and one in general morphology of plants (see below).

1. Zoological instruction, season of 1908, will be in charge of Winterton C. Curtis, assistant professor of zoology, University of Missouri, assisted by Paul M. Rea, professor of biology, College of Charleston, and director of the Charleston Museum; Max Morse, tutor in natural history, College of the City of New York; Lawrence E. Griffin, professor of biology, Missouri Valley College; Edward E. Wildman, instructor in biology, Central High School, Philadelphia, and John W. Scott, Westport High School, Kansas City.

Although Dr. L. L. Woodruff, instructor in biology, Yale University, is leaving the staff in zoology for that in embryology, he has consented to give the lectures on protozoa in 1908.

The conduct of the work in this subject will not differ substantially from the plan which has proved successful in recent years. Lectures and laboratory work are supplemented by extensive collecting trips, during which the student has opportunity to observe the methods of marine collecting and to study a wide range of marine forms in their natural surroundings.

2. The course in embryology will be in charge of Professor Gilman A. Drew, of the University of Maine, Orono, Maine, assisted by Dr. L. L. Woodruff, instructor in biology, Yale University, and Dr. W. E. Kellicott, professor of biology in the Woman's College of Baltimore.

It is the aim of this course to meet the needs of those who desire to get an insight into fundamental problems, and to serve as a basis for those who desire to begin independent investigation. It will supplement the usual college course in embryology, laying special weight on questions of general importance that can best be approached by the study of living marine material.

The work will include the study of organization, maturation and fertilization in the egg, the early development, types of gastrulation, and the effects of different conditions on development. The advantage of following the actual process of development in the living egg, instead of comparing a few preserved stages of development, can not be overestimated.

The course will be accompanied by lectures delivered by members of the staff and by other investigators working at the laboratory. For the course in embryology, the course in zoology or its equivalent is a prerequisite.

3. The course in comparative physiology will be in charge of members of the same staff as in 1907, viz.:

Albert P. Mathews, professor of physiological chemistry, University of Chicago.

E. P. Lyon, professor of physiology, University of St. Louis.

Ida H. Hyde, professor of physiology, University of Kansas.

R. S. Lillie, instructor in comparative physiology, University of Pennsylvania.

A. J. Carlson, assistant professor of physiology, University of Chicago.

Edward G. Spaulding, assistant professor of philosophy, Princeton University.

Oliver P. Terry, instructor in physiology, Purdue University.

Horatio H. Newman, instructor in zoology, University of Michigan.

Changes in the staff for 1908 will be announced later. The course will include study of the physico-chemical constitution of protoplasm, physics of cell-division and contractility, phenomena of inheritance from a physico-chemical standpoint, the physical basis of conduct, comparative physiology of the heart and circulation and comparative physiology of the central nervous system. Lectures will be given by members of the staff and others.

IV. The following courses will be offered in botany:

1. Morphology and Taxonomy of the Algæ, conducted by Dr. George T. Moore, assisted by George R. Lyman, assistant professor of botany, Dartmouth College, and R. R. Gates, fellow in botany, University of Chicago.

A general course upon the algæ, designed to give a detailed knowledge of the habits, structures and life histories of this group.

2. Morphology and Taxonomy of the Fungi, conducted by Dr. Lyman and Mr. Gates. A general course upon the fungi similar to that outlined for the algæ.

3. General Morphology of Plants.

No prerequisites are stated for this course, which will be conducted either by Professor John M. Coulter or Professor C. J. Chamberlain, of the University of Chicago, with assistants: an outline of the plant kingdom, based upon the study of selected types. Emphasis will be placed upon the facts connected with the evolution of plants, such as the origin of sex, alternation of generations, heterospory, origin of the flower, origin of the seed, etc. The general relationships and classification of the flower groups will also be discussed, including the history of the groups as developed by paleobotany.

It is expected that Mr. W. R. Maxon, of the United States National Museum, will act as collector in botany. The usual lectures and seminars will be offered.

FRANK R. LILLIE

UNIVERSITY OF CHICAGO

CHARLES P. MATTHEWS

CHARLES P. MATTHEWS, professor of electrical engineering at Purdue University, died at Phoenix, Arizona, on Saturday, November 23, 1907. Professor Matthews was of Vermont stock, his family going from that state to New York in 1852, where, at Fort Covington, he was born September 18, 1867. At the time of his death he was, therefore, a little more than forty years of age.

He attended the St. Johnsbury Academy at St. Johnsbury, Vermont, graduating there in 1887. He then entered Cornell University, graduating from Sibley College with the degree of mechanical engineer in 1892. In 1901 he received the degree of doctor of philosophy from his alma mater.

Immediately after graduation he became instructor in physics and applied electricity at Cornell, serving in that capacity four years, until 1896. At that time he was called to Purdue and was appointed associate professor of electrical engineering. In 1905 he succeeded Professor Goldsborough as head of the School of Electrical Engineering and from this time until his death he was continuously a member of the Purdue faculty.

During Professor Matthews's connection with the School of Electrical Engineering, it has grown to be the largest in the country in point of numbers. In this development he has had a large share. His instruction was of the highest order not only on account of his professional ability and training, but quite as much on account of his exceptional personality and gifts.

He made valuable contributions to his science, his chief work being an investigation of photometric standards for arc lamps. This was done in connection with the National Electric Light Association. In this, he directed all the experimental work, designed the apparatus and prepared four reports aggregating about two hundred pages. In this connection he devised and patented an integrating photometer. This instrument received a gold medal at the Louisiana Purchase Exposition. He was also collaborator in the production of text-books in physics and elec-

tricity with Professors Nichols and Shearer, of Cornell, and with Professor Esterline, of Purdue, and he had published a number of papers on electrical subjects. He was a member of the honor fraternity, Sigma Xi.

THE SMITHSONIAN INSTITUTION

A regular meeting of the board of regents of the Smithsonian Institution was held on December 3, 1907, at ten o'clock, at the institution, the chancellor, Chief Justice Fuller, presiding, and the following regents being present: Vice-president Charles W. Fairbanks, Senator Shelby M. Cullom, Senator Henry Cabot Lodge, Senator Augustus O. Bacon, Representative John Dalzell, Representative James R. Mann, Representative William M. Howard, Dr. Andrew D. White, the Hon. John B. Henderson, and the secretary of the institution, Dr. Charles D. Walcott.

The secretary presented his report for the year ending June 30, 1907, to the board, which was accepted. Statements were received from the executive and permanent committees. The secretary presented a statement of the affairs of the institution since the close of the fiscal year. Considerable attention was given to the National Gallery of Art, and a resolution was adopted urging congress to make an appropriation for adapting the large hall of the Smithsonian building to the purposes of a gallery of art. A resolution was also adopted tendering the thanks of the regents to William T. Evans for the gift of his valuable collections of paintings by American artists, and to the trustees of the Corcoran Gallery of Art for their courtesy in providing temporarily for the exhibition of this collection.

THE AMERICAN FEDERATION OF TEACHERS OF THE MATHEMATICAL AND THE NATURAL SCIENCES

The second annual meeting of the American Federation of Teachers of the Mathematical and the Natural Sciences will be held in Chicago on January 1, 1908, at 2 p.m., in room 20 of the Kent Chemical Laboratory, University of Chicago. The purpose of the federation is a more unified and concentrated effort on the part of its members to better the teaching of mathematics and of the natural sciences. The membership of the federation consists entirely of associations, each member being represented by delegates at the meetings. At the last meeting, a tentative organization was formed by the following associations: The Association of Teachers of Mathematics of the Middle States and Maryland; The New York State Science Teachers Association; The Central Association of Science and Mathematics Teachers; The Association of Teachers of Mathematics of New England; The Physics Teachers Association of Washington City; The Missouri Society of Teachers of Mathematics and Science; The New Jersey State Science Teachers Association.

Since the last meeting, the following associations have signified their intention of being represented at the coming meeting in Chicago: The Michigan Schoolmasters Club; The New England Association of Chemistry Teachers; The New York Physics Club; The Indiana Association of Science and Mathematics Teachers; The Association of Ohio Teachers of Mathematics and Science. At this meeting on January 1, the final form of the organization will be decided. All organizations whose leading purpose is the betterment of the teaching either of mathematics or of the natural sciences are invited to send delegates to this meeting and thus to take part in the organization of the federation. By joining this body, an association will lose in no way its individuality or its right to work in its own field in its own way; but it will gain an official means of keeping in touch with the work of the other associations, and will receive from the federation suggestions as to the ways in which all the associations may work together on their common problems.

C. R. Mann,
Secretary

University of Chicago

THE CONVOCATION WEEK MEETINGS OF SCIENTIFIC SOCIETIES

The American Association for the Advancement of Science and the national scientific societies named below will meet at the Uni-

versity of Chicago during convocation week, beginning on December 30, 1906.

American Association for the Advancement of Science.—December 30–January 4. Retiring president, Professor W. H. Welch, The Johns Hopkins University, Baltimore, Md.; president-elect, Professor E. L. Nichols, Cornell University, Ithaca, N. Y.; permanent secretary, Dr. L. O. Howard, Cosmos Club, Washington, D. C.; general secretary, President F. W. McNair, Houghton, Mich.

Local Executive Committee.—Charles L. Hutchinson, chairman local committee; John M. Coulter, chairman executive committee; John R. Angell, Thomas C. Chamberlin, Joseph P. Iddings, Frank R. Lillie, Charles R. Mann, Robert A. Millikan, Charles F. Millspaugh, Alexander Smith, J. Paul Goode, local secretary.

Section A, Mathematics and Astronomy.—Vice-president, Professor E. O. Lovett, Princeton University; secretary, Professor G. A. Miller, University of Illinois, Urbana, Illinois.

Section B, Physics.—Vice-president, Professor Dayton C. Miller, Case School of Applied Science; secretary, Professor A. D. Cole, Vassar College, Poughkeepsie, N. Y.

Section C, Chemistry.—Vice-president, Professor H. P. Talbot, Massachusetts Institute of Technology; secretary, Professor Charles L. Parsons, New Hampshire College, Durham, N. H.

Section D, Mechanical Science and Engineering.—Vice-president, Professor Olin H. Landreth, Union College; secretary, Professor Wm. T. Magruder, Ohio State University, Columbus, Ohio.

Section E, Geology and Geography.—Vice-president, Professor J. P. Iddings, University of Chicago; secretary, Dr. Edmund O. Hovey, American Museum of Natural History, New York City.

Section F, Zoology.—Vice-president, Professor E. B. Wilson, Columbia University; secretary, Professor C. Judson Herrick, University of Chicago.

Section G, Botany.—Vice-president, Professor C. E. Bessey, University of Nebraska; secretary, Professor F. E. Lloyd, Desert Botanical Laboratory, Tucson, Arizona.

Section H, Anthropology.—Vice-president, Professor Franz Boas, Columbia University; secretary, George H. Pepper, American Museum of Natural History, New York City.

Section I, Social and Economic Science.—Vice-president, Dr. John Franklin Crowell, New York City; secretary, Professor J. P. Norton, Yale University, New Haven, Conn.

Section K, Physiology and Experimental Medicine.—Vice-president, Dr. Ludvig Hektoen, University of Chicago; secretary, Dr. Wm. J. Gies, College of Physicians and Surgeons, Columbia University, New York City.

Section L, Education.—Vice-president, Hon. Elmer E. Brown, U. S. Commissioner of Education; acting secretary, Professor Edward L. Thorndike, Teachers College, Columbia University, New York City.

The American Society of Naturalists.—December 28. President, Professor J. Playfair McMurrich, University of Toronto; secretary, Professor E. L. Thorndike, Teachers College, Columbia University, New York City. Central Branch, president, Professor R. A. Harper, University of Wisconsin; secretary, Professor Thomas G. Lee, University of Minnesota, Minneapolis, Minn.

The American Mathematical Society. Chicago Section, December 30, 31. Chairman, Professor Edward B. Van Vleck; secretary Herbert E. Slaught, 58th St., and Ellis Ave., Chicago, Ill.

The American Physical Society.—President, Professor E. L. Nichols, Cornell University; secretary, Professor Ernest Merritt, Cornell University, Ithaca, N. Y.

The American Chemical Society.—December 27–January 2. President, Professor Marston T. Bogert, Columbia University; secretary, Professor Charles L. Parsons, New Hampshire College, Durham, N. H.

The Association of American Geographers.—December 31–January 1. Acting-president, Professor R. S. Tarr, Cornell University, to whom correspondence should be addressed; secretary, Albert P. Brigham, 123 Pall Mall, London, Eng.

The Association of Economic Entomologists.—December 27, 28. President, Professor H. A. Morgan, Knoxville, Tenn.; secretary, A. F. Burgess, Columbus, Ohio.

The American Society of Biological Chemists.—December 30–January 2. President, Professor Russell H. Chittenden, Yale University; secretary, Professor William J. Gies, College of Physicians and Surgeons, Columbia University, New York City.

The Society of American Bacteriologists.—December 31–January 2. Vice-president, F. D. Chester, Delaware Agricultural College, Newark, Del.; secretary, Professor S. C. Prescott, Massachusetts Institute of Technology.

The American Physiological Society.—Beginning December 31. President, Professor W. H. Howell, Johns Hopkins University; secretary,

Professor Lafayette B. Mendel, 18 Trumbull St., New Haven, Conn.

The Association of American Anatomists.—January 1–3. President, Professor Franklin P. Mall; secretary, Professor G. Carl Huber, 1330 Hill St., Ann Arbor, Mich.

The American Society of Zoologists.—Central Branch. Secretary, Professor Thomas G. Lee, University of Minnesota, Minneapolis, Minn.

The Botanical Society of America.—December 27–29. President, Professor George F. Atkinson, Cornell University; secretary, Dr. D. S. Johnson, Johns Hopkins University.

The Botanists of the Central States.—Business Meeting. President, Professor T. H. Macbride, University of Iowa; secretary, Professor H. C. Cowles, University of Chicago, Chicago, Ill.

The American Psychological Association.—December 27, 28. President, Dr. Henry Rutgers Marshall, New York City; acting secretary, Professor R. S. Woodworth, Columbia University, New York City.

The Western Philosophical Association.—Secretary, Dr. John E. Bowdoin, University of Kansas, Lawrence, Kans.

The American Anthropological Association.—December 30, January 4. President, Professor Franz Boas, Columbia University; secretary, Dr. Geo. Grant MacCurdy, Yale University, New Haven, Conn.

The American Folk-lore Society.—December 30–January 4. President, Professor Roland B. Dixon, Harvard University; secretary, Dr. Alfred M. Tozzer, Harvard University, Cambridge, Mass.

Other national societies will meet as follows:

NEW HAVEN

The American Society of Zoologists.—Eastern Branch. December 26, 28. President, Dr. C. B. Davenport, Cold Spring Harbor, N. Y.; secretary, Professor W. L. Coe, Yale University, New Haven, Conn.

The American Society of Vertebrate Paleontologists.—December 26–28. President, Professor Bashford Dean, Columbia University; secretary, Professor Frederick B. Loomis, Amherst College, Amherst, Mass.

NEW YORK

The American Mathematical Society.—December 27, 28. President, Professor H. S. White, Vassar College; secretary, Professor F. N. Cole, Columbia University.

ALBUQUERQUE, N. M.

The Geological Society of America.—December 30–January 4. President, President Charles R. Van Hise, University of Wisconsin; secretary, Dr. Edmund O. Hovey, American Museum of Natural History, New York City.

ITHACA

The American Philosophical Association.—December 26, 28. President, Professor H. N. Gardiner, Smith College; secretary, Professor Frank Thilly, Cornell University, Ithaca, N. Y.

NEXT SUMMER, AT SOME PLACE TO BE DETERMINED

The Astronomical and Astrophysical Society of America.—President, Professor Edward C. Pickering, Harvard College Observatory; secretary, Professor Geo. C. Comstock, Washburn Observatory, Madison, Wisconsin.

SCIENTIFIC NOTES AND NEWS

MR. ANDREW CARNEGIE has added two million dollars to the endowment of the Carnegie Institution of Washington. Mr. A. J. Montague of Virginia and Mr. W. B. Parsons of New York have been elected trustees of the institution.

NOBEL prizes have been awarded as follows: In physics to Professor A. A. Michelson of the University of Chicago; in chemistry to Professor Eduard Buchner of the Berlin Agricultural School; in medicine to M. Laveran of Paris; in literature to Mr. Rudyard Kipling, and for the promotion of peace to M. Renault and M. Moneta.

MR. ALEXANDER AGASSIZ and Professor Adolf von Baeyer have been elected honorary members of the Vienna Academy of Sciences.

MISS FLORENCE NIGHTINGALE, now in her eighty-eighth year, has been decorated by King Edward with the Order of Merit.

PROFESSOR E. B. TITCHENER, of Cornell University, has been appointed non-resident lecturer on psychology at Columbia University for the academic year 1907–08.

AT the sixtieth anniversary meeting of the New York Academy of Medicine on November 29, Col. W. C. Gorgas, chief sanitary officer of the Isthmian Canal Commission, de-

livered an address on the sanitary problems encountered in the canal zone.

The regular meeting of the Columbia Chapter of the Society of Sigma Xi was held with the department of chemistry on December 12. Professor C. F. Chandler addressed the society on Recent Progress of Electrochemistry. The lecture was an exposition of the theory and practise of electrochemistry as employed in the great industries built up during the last few years at Niagara Falls, and was illustrated by a collection of specimens of both materials and products.

The annual meeting of the New York Academy of Sciences will be held on Monday, December 16, at the Hotel Endicott, corner of Columbus Avenue and Eighty-first Street, at 7 P.M. After the annual dinner Professor N. L. Britton will deliver his address as retiring president of the academy, on "The New York Botanical Garden, its organization and construction."

A Journal Club in General Science has been organized at the New York City College with membership consisting of the instructors in the science courses. Professor Alfred G. Compton has been elected president and Dr. George G. Scott secretary.

Professor C. A. Ewald has announced his intention of retiring from the editorship of the *Berliner klinische Wochenschrift* on January 1.

The recent opening of a new laboratory of botany at Wellesley College was made the occasion of a reception to Professor Emeritus Susan M. Hallowell, at the head of the department of botany from the opening of the college in 1875 to 1902.

Lieutenant Frank H. Lahm, of the United States Army, is in Germany on leave of absence from the War Department to study German aeronautics.

Dr. Paul Haupt, of Johns Hopkins University, honorary associate in historic archeology in the U. S. National Museum, has been designated by Secretary Walcott as the representative of the National Museum and the Smithsonian Institution at the fifteenth international congress of orientalists to be held in Copenhagen during the second half of the month of August, 1908.

A statue of the late Professor Tillaux is to be erected in the school of practical anatomy of the University of Paris at Clamart. The statue is by M. Chaplain.

Bernard J. Harrington, Ph.D., professor of chemistry in McGill University, died on November 29 in Montreal. We learn from a notice in the *Yale Alumni Weekly* that he was born on August 5, 1848, at St. Andrews, P. Q., and was graduated from McGill University in 1869, taking first honors in natural science and winning the Logan gold medal. Pursuing a graduate course at Sheffield Scientific School, Yale University, he received the degree of doctor of philosophy in 1871 and the prize in mineralogy. He was appointed in the same year lecturer in chemistry at McGill, and in 1872 succeeded Dr. T Sterry Hunt as chemist and mineralogist to the Geological Survey of Canada. He filled both posts for seven years, retiring from the Geological Survey in 1879 in order to devote his entire time to teaching, giving lectures in mining and metallurgy in addition to his regular courses. In 1883 Dr. Harrington was appointed Greenshields professor of chemistry, but continued to hold the lectureship of mining and metallurgy until 1891. He was for many years editor of *The Canadian Naturalist*, and was the author of numerous monographs on the mineralogy of Canada. He published in 1883 "The Life of Sir William Logan, First Director of the Geological Survey in Canada."

We regret to record the deaths of Dr. Georg Sidler, honorary professor of astronomy at Bern, of Dr. Maurits Snellen, director of the Meteorological Institute at Utrecht, and of Dr. Pietro Pavesi, professor of zoology at Pavia.

The Central Branch of the American Society of Zoologists will unite with Section F of the American Association for the Advancement of Science in a joint program at the meeting to be held at the University of Chicago during convocation week. The Central Branch of the American Society of Natural-

ists, Professor R. A. Harper, University of Wisconsin, president, will hold no separate meeting, but will unite with the society in a program already announced.

THE next meeting of the Department of Superintendence of the National Educational Association will be held in Washington, D. C., on February 25, 26 and 27, 1908.

THE next meeting of the Pathological Society of Great Britain and Ireland will be held at the Pathological Laboratories of the Royal Army Medical College, London, on January 3, at 2 P.M., and will be resumed on the following day at 10 A.M. The members will dine together on the evening of January 3.

THE chief justice, presiding at a meeting of the National Preservation Society, at Cape Town, on November 23, urged the need of stronger measures to preserve rare flora and fauna from extinction. The gnu, or wildebeest, the gemsbok, the mountain zebra, the eland, and the giraffe were all nearly extinct. He said he remembered when a barrister on circuit seeing great herds where now there were railway stations. He also hoped that if the Table Mountain Railway were sanctioned proper safeguards would be taken against desecration.

WE learn from the London *Times* that the meeting of the Second International Conference on the Sleeping Sickness, which was to have assembled at the British foreign office on November 1, has been deferred in deference to the wishes of the German government, which has pointed out the advantage which would be gained if their delegates were in a position to submit to the conference the fruits of the recent labors of Professor Koch. Professor Koch has lately been engaged in an exhaustive inquiry into this question on the spot and has now returned to Berlin, where he is at present engaged in the preparation of his report. As this work must necessarily occupy a considerable time, the conference is unlikely to assemble before the middle of February. Meanwhile, however, meetings of the British delegates to the forthcoming conference are being held from time to time at the foreign office to consider various points connected with the work of the conference.

FROM the same source we learn that there has been formed in Liverpool, with Sir Alfred Jones as chairman, an independent sleeping sickness committee. It has for its object the collection of information dealing with sleeping sickness, the stimulation of research into the cause, method of transference and cure of the disease, and the publication from time to time of communications with reference to it. The committee comprises, in addition to Sir Alfred Jones, the Lord Mayor of Liverpool; Professor Moore, director of the biochemical department of Liverpool University; Professor Salvin-Moore, director of the cytological department; Professor Annett, director of the comparative pathology department; Professor Sherrington, director of the physiological department; Dr. Stephens, Walter Myers lecturer in tropical medicine; and Dr. Anton Breine, director of the Runcom Research Laboratories. The corresponding secretaries include Professor Sir Robert Boyce, F.R.S., dean of the Liverpool School of Tropical Medicine.

UNIVERSITY AND EDUCATIONAL NEWS

BY the death at Boston of Silliman Bladgen (Yale '69), Yale University will obtain $50,000. Mr. Bladgen was a nephew of Benjamin D. Silliman (Yale '24), of Brooklyn, who died in 1901. By his will be gave his nephew a life interest in $50,000, which now reverts to the college without restrictions.

UNDER the will of Mrs. James Nichol of North Amherst, Oberlin College receives approximately $25,000, which will be used for general endowment. For several years the college has had a small fund toward the erection of a men's building to serve as the center of their interests, both religious and secular. Twenty-five thousand dollars more has recently been pledged for this purpose.

THE new building containing the laboratories for zoology, botany, physics and chemistry in Kentucky University, toward the erection of which Mr. Andrew Carnegie con-

tributed $25,000 some time ago, is nearing completion, and will be ready for occupancy in a short time.

THE National Educational Association has appointed a committee to investigate the entrance requirements to the technical schools of the country, and to consider the question of establishing uniform entrance requirements. The members are: President Atkinson, Brooklyn Polytechnic Institute; Dean Cooley, University of Michigan; Professor Tyler, secretary of the Massachusetts Institute of Technology; Dean Marston, University of Iowa; Professor Kimbel, Cornell; Professor Baker, University of Illinois, and Dean Goetze, School of Applied Science, Columbia University.

THE faculty of the Cornell University Medical College announces that in and after 1908 candidates for admission to the college must be (1) graduates of approved colleges or scientific schools; or (2) seniors in good standing in Cornell University or in any other approved college or scientific school whose faculty will permit them to substitute the first year of a professional course for the fourth year in arts and science, and which will confer upon them the bachelor's degree upon the satisfactory completion of the first year of the course in the Cornell University Medical College; or (3) persons who, while not possessing a bachelor's degree, give evidence by examination that they have acquired an equivalent education and a training sufficient to enable them to profit by the instruction offered in the Medical College. In and after 1909 all candidates for admission to the Medical College must have at least such knowledge of physics and inorganic chemistry as may be obtained in college by a year's course in these subjects when accompanied by laboratory work. In and after 1910 all candidates for admission must possess a similar knowledge of biology.

THE total number of doctorates of philosophy conferred by the University of Chicago has now reached four hundred and seventy.

BY a decree of the Oxford convocation any student who has obtained the degree of Ph.D. at a university of the German empire, the Austro-Hungarian empire, or Switzerland, may be admitted to the status and privileges of a junior foreign student; and if he has obtained it with distinction (*cum laude*) to those of a senior foreign student.

IT is said that the number of American students at the University of Berlin has fallen to the smallest figure on record. Only sixty-eight men and twenty-seven women from America are enrolled, as compared with a total of more than two hundred three years ago and more than four hundred ten years ago. A similar state of affairs is said to exist at Heidelberg, Göttingen, Jena, Leipsic, Halle and other prominent universities.

REV. GEORGE ALEXANDER, D.D., Union, '66, pastor of the University Place Presbyterian Church of New York City, will be the next president of the Union College, succeeding Rev. Dr. Andrew V. Raymond, who resigned last June to accept a Buffalo pastorate. Dr. Alexander was offered the presidency of the college at that time, but consented only to become acting president.

PROFESSOR JOHN C. SHEDD, who has held the chair of physics in Colorado College, has resigned to accept the office of dean in Westminster University, Denver, Col.

B. M. WALKER, Ph.D. (Chicago), who has for some years been connected with the Mississippi Agricultural and Mechanical College, is now director of the school of engineering and professor of mathematics in that institution.

JOHN C. HESSLER, Ph.D. (Chicago), has been appointed professor of chemistry in James Millikan University, Decatur, Ill.

WILLIAM J. MOORE, assistant professor of electrical engineering at the Stevens Institute of Technology, has resigned to accept a professorship in the North Carolina State College of Agriculture and Mechanical Arts.

PROFESSOR WALDEN, of Riga, has declined a call to succeed Mendelejef at St. Petersburg.